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The Journal of Bone & Joint Surgery

OSTEOCHONDRITIS DISSECANS.*

BY ALBERT H. FREIBERG, M.D., CINCINNATI, OHIO.

THE disease of joints which was first described under this name by Koenig, in 1888, has become of ever increasing interest during the past ten years. The article by Freiberg and Woolley, published in 1910, was the first in the English language, so far as I have been able to ascertain. Since this time quite a few papers have appeared upon this subject, notably those of Ridlon, Brackett and Hall, Colvin, and others. For the most part, with the exception of those named, the discussion has involved this disease simply as one of the factors concerned in the production of loose bodies in joints, rather than as a clinical entity. Largely as the result of the routine study of abnormal joints by means of the x-ray, it has become apparent that we must look upon this disease as a typical joint lesion apart from its effect of producing loose bodies; the accumulation of clinical evidence and the results of operative experience seem, moreover, to show that some of our conclusions cannot be justified in respect of its etiology and essential nature.

The disease is not frequent, even though far from rare, since the series of Brackett and Hall, which comprises nine cases, is perhaps the largest one reported. Most of these cases involved men whose occupation was

*Read at the meeting of the American Orthopedic Association, held at Washington, D. C., May 1-3, 1922.

presumed to render them liable to trauma of the knee; all of the cases involved this joint and in all the affection was unilateral. The history of the trauma is practically always indefinite; the injury to which the beginning of the disease is ascribed is most often not a severe one and in many cases trauma is rather assumed than known. In Colvin's series of four cases trauma is definitely shown in none. In all of the reported cases which belong without question in this category, the joint is described as free from other evidences of disease. On the other hand, cases are reported in which symptoms of loose bodies recurred after operation; several cases of the involvement of the second knee may be found and several instances are given in which the elbow has been the seat of this lesion in a typical manner. The occasion for this paper is an experience with five cases which it has been possible to investigate with care and in the light of previous observations; each case is presented in relation to certain features of especial interest in the study of the subject in general. I find it impossible to proceed with the account of these cases and the discussion of their practical bearings without paying a tribute of admiration to the great surgeon, Franz Koenig, to whose remarkable clinical acumen and scientific attitude we owe our first acquaintance with this interesting lesion. Let us not fail to remember that he was without the aid of the x-ray and that in his era the opening of the large joints was a very different matter from that of to-day. I cannot refrain from translating his words:

"Those loose bodies which are formed in a joint, for the most part gravely diseased, stand in diametric contrast to such whose genesis is to be ascribed to an entirely circumscribed disease of the joint ends, which has been described as osteochondritis dissecans.

"Without any injury, there separate from the joint ends fragments of varying size, in consequence of a process as yet unexplained; their bony surface becomes covered with a dense connective tissue containing cartilage cells, here and there. In the same manner the defect in the bone becomes covered over. In some cases a smaller body composed entirely of bone and smooth with the appearance of necrotic bone, lay under a larger piece perhaps 2 cm. in diameter. These pieces often fitted almost exactly in the corresponding bone defect, seeming at times somewhat too large because the pits in the bone had become filled in. Aside from this, together with a fluid effusion and slight villous hypertrophy, these joints looked perfectly sound and they remained so after the removal of the loose bodies." (Allgem. Chir., 1889, p. 751.)

Case 1.—A lady of 49, previously in perfect health, began to experi-

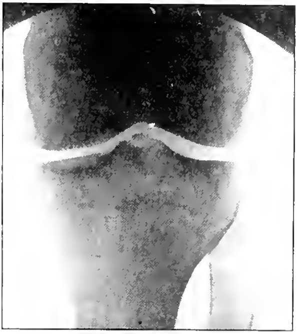

FIG. 1.—CASE 1.

ence discomfort in the left knee in the spring of 1917. She remembered having a sudden twinge in the joint while in a gymnastic class and from this time until after operation the knee was never normal, the chief complaint being inability to completely extend. It is absolutely certain that there was no injury to the joint beyond that mentioned and I feel sure of the reliability of the statement. When examined in November, 1917, there was no swelling of the knee and no tenderness on pressure. Motion was free in flexion, but extension was limited by about ten degrees and there was a definite limp; after walking a short distance the joint became painful. For about two weeks before operation there had been often a sensation as if something had slipped out of place. Examination on November 16 showed full motion in extension and the x-ray was made on this day. (Fig. 1.) This showed the joint to be perfectly normal except for the typical lesion in the internal condyle of the femur; a niche containing an apparently loose piece of bone, and two small fragments of bone in the joint line just above the tibial spine. It seemed likely that the movement of this small piece was responsible for the hindrance to extension which had been present most of the time during the preceding six months.

On November 20, 1917, the joint was opened by internal oblique incision; the large loose body was found lying in its niche in the internal condyle and two smaller ones were found attached to it by a slender pedicle about 2.5 cm. long, so that the three pieces came out together. Recovery was uneventful and the function of the joint has been perfect ever since.

COMMENT.

The assumption of direct traumatic origin in this case would be entirely gratuitous; it is apparent that the first symptom was produced by movement of a small body already free at that time. There is no way of ascertaining how long the bodies had been loose or when the separation began. In this knee the spine of the tibia is not abnormally long. Finally, there would seem to be no reason for choosing the transpatellar method of arthrotomy in such a case.

Case 2.—A school girl, seventeen years old, the daughter of well-to-do parents, was examined in July, 1916, because of trouble with the left knee. Almost one year before, this knee had been injured in a hockey game. About one month after this injury, which was not severe, she had pain in the joint and there was water in the knee. This subsided and the knee gave her only occasional slight discomfort until one month before I examined her when she injured the knee alighting from a street car; she was unable to bend her knee for a day and an effusion was apparently present for a time. There was a limp from this time on and a sensation of something slipping several times daily. My examination showed no effusion or muscular atrophy and there was no limitation of motion; during my examination she felt something slip in the joint. There was some tenderness on the mesial side of the knee. The

Fig. 2.—Case 2. Note the long mesial tubercle of the tibial spine.

x-ray (Fig. 2.) showed a loose body, about 1.5 cm. long, lying in a niche in the mesial condyle of the femur; no second loose body can be seen. The mesial tubercle of the tibial spine is very long, but the joint appears otherwise normal. The loose body was removed by internal oblique incision; it lay in its niche and there was a slender pedicle. The body was half again as large as it appears in the x-ray by reason of its connective tissue covering. Recovery was uneventful and this knee has remained perfectly well.

I saw this patient again in 1920 because of trouble with the other knee. In 1918, while I was in military service, she had symptoms appear in the right knee like those which she had experienced in the left. There had been no trauma to this knee so far as she knew. The surgeon who was consulted made the diagnosis of osteochondritis dissecans, with two loose bodies, and they were removed by arthrotomy. She consuted me because the symptoms in this knee had recurred and the x-ray which she brought showed a loose body about 0.5 cm. long, in the joint line. The remains of the defect in the condyle could be made out, though indistinctly, and there was no evidence of recent bone loss at this place. For reasons of no present interest I did not have the opportunity to operate upon this joint and the x-ray of the right knee was not left with me.

COMMENT.

Like my first case, reported in 1910, this case presents the interesting involvement of the second knee without demonstrable trauma and likewise the recurrence of symptoms in the second knee after operation under circumstances which make it probable, at least, that a loose body had been left behind. The length of the mesial tubercle of the tibial spine also seems worthy of attention. The particular interest in this case lies in the behavior of the second knee; the recurrence of symptoms after operation makes it seem possible that there had been formed an additional loose body. This is rendered unlikely by the fact that the first knee has remained well and that there was no evidence in the x-ray of the second knee that any further change had occurred at the site in the mesial condyle. While the niche was still easily to be seen, it was smooth with well rounded edges. In this case, also, I feel sure that a careful study of the radiogram before operation would have revealed the presence of the third loose body which was responsible for the recurrence; were it so small as to preclude this, I doubt the likelihood of finding it by the transpatellar operation. At the same time, it is possible that its situation, had it been seen, would have been such as to make this the desirable method of entering the joint.

Case 3.—For the privilege of reporting this case I am obliged to Dr. Howard A. Smith, of Marietta, O. The patient is a young man who was examined for disability incident to military service. When 14 years old this knee was locked several times with a period of soreness following. He had attacks of locking once or twice a year up to the time of entering service. At that time the knee was examined, but nothing definite was found, and no x-ray was made. While overseas he had a fall in the trenches and the knee now became continuously troublesome, so that it was opened at Camp Sherman and two loose bodies were removed. Since then there has been much soreness and stiffness and occasionally swelling with effusion, but no locking. At the present time he is practically free from symptoms. The x-rays (Fig. 3.) show the

Fig. 3.—Case 3. Long mesial tubercle.

typical niche in the mesial condyle, about 2 cm. wide and occupied by a body measuring about 1.5 x 1.0 cm. There is also a shadow in the posterior part of the joint which might be taken for a loose body, especially in the lateral view; it is apparent, however, that this is the fabella or gastrocnemial sesamoid. It is found in the typical situation, behind the external condyle, in the antero-posterior view. Attention is called to the long internal tubercle of the tibial spine; in the affected knee it appears to impinge upon the femur. While it is quite long in the normal (right) knee, there is no such appearance of impingement.

COMMENT.

In this case, also, we have recurrence of symptoms after operation; there was, however, an injury which might be held to account. It is unfortunate that we have no information of the precise nature of operation and its findings. At the same time it appears likely that the loose body at present to be seen was in existence at the time of operation and perhaps even from childhood, but that it was either not sought for or was not found. In any event, this case shows the need for most careful study of the x-ray before proceeding with operation.

CASE 4.—A man 28 years old presented himself in February, 1920, because of trouble with the left knee; he had known for some years that this joint was not normal. His occupation is mercantile, but he has always indulged in strenuous athletic sports and has had numerous injuries, but no serious ones, and he could remember none affecting this joint especially. During the past year the left knee had frequently annoyed him by reason of stiffness and he had several attacks of locking. Examination showed some muscle atrophy in the thigh, slight limitation of extension of the knee, slight capsular thickening and some tenderness over the front of the joint and mesially. There was no fluid effusion at this time. X-rays (Fig. 4) showed a large typical defect in the

FIG. 4.—CASE 4. February, 1920.

internal condyle of the femur, containing a spongy looking fragment; in the lateral view, made somewhat obliquely, there appeared a dense nucleus or smaller fragment about 0.5 cm. long lying in the niche. In this view there was also seen a larger dense shadow, above the patella, about 2.2 cm. long. Both tubercles of the tibial spine seemed noticeably long. Operation was proposed, but was declined at this time.

In March, 1921, more than a year later, I saw him again. He had wrenched his knee two days before and the joint was now very painful and distended with fluid. He had had numerous attacks of locking and had often felt a movable body in the upper recess on the inner side of the joint. X-rays (Fig. 5) now showed two large loose bodies; one of spongy structure behind the patella in the lateral view and about 2.2 cm. long, and one of dense character in the joint line, 1.5 cm. in length. This dense body seemed to me to doubtless represent the original dense nucleus which had increased in size about four times during the year which had elapsed. After ten days of recumbency, during which the effusion was almost entirely absorbed, operation was undertaken. Immediately before taking him to the operating room a third pair of x-rays was made (Fig. 6), which showed both bodies in the upper recess on the fibular side of the joint. Care was taken to prevent any motion of the joint before the incision was made. The joint was opened in the fully extended position, above the patella and on the outer side. Both bodies were easily found and removed. Both were about twice as large as the x-ray shadows had indicated. Recovery was uneventful and the joint has remained perfectly well during the year which has passed since operation.

COMMENT.

In this case it is more than likely that trauma played an influence in the etiology. The simpler method of opening this joint seemed justified by reason of the fact that the niche in the condyle appeared entirely empty in the preoperative x-rays. Otherwise the transpatellar incision would have seemed proper. During the year which had elapsed after the first examination, both bodies had evidently lost their attachment to their bed of origin and had become freely movable; during the ten days which had passed between taking the second and third sets of x-rays, the bodies had completely changed their position, but we succeeded in maintaining them where last shown immediately before incision was made. There is no question, in my mind, that the dense nucleus increased greatly in size after it had become separated from its bed and within a period of one year.

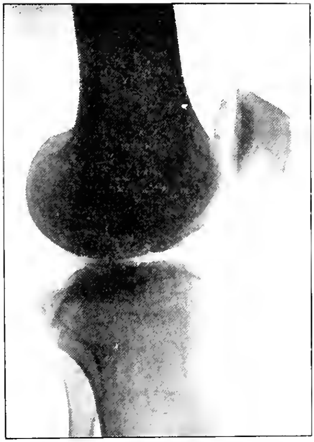

FIG. 5—CASE 4. March 19, 1921.

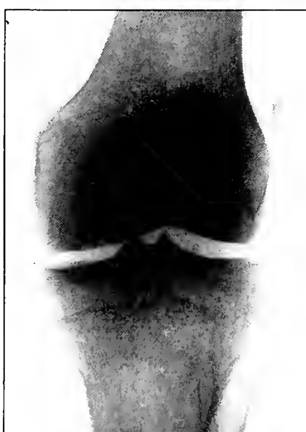

FIG. 6.—CASE 4. Day of operation.

Case 5.—On March 31, 1921, I examined a boy 16 years old because of trouble with his right elbow. It began several months before with stiffness which had been steadily growing worse. He knew of no injury to which the condition could be attributed. He has had no pain excepting during one night, several weeks before I saw him. Some time before that he had struck his elbow and it had been very painful for a short time, but this was long after the beginning of the trouble. He had been examined by another surgeon and told that the elbow was tuberculous. Examination showed the elbow thickened on the radial side and the head of the radius seemed unduly prominent. The elbow could not be extended beyond 110°, although flexion was entirely free. A firm, rather elastic and slightly movable mass could be felt between the external condyle of the humerus and olecranon. A number of x-rays were made which showed an excavation in the external condyle of the humerus, about 1.5 x 0.4 cm., containing a mass of bone of lesser density (Fig. 7). This mass had evidently moved somewhat from its original

Fig. 7.—Case 5.

position. The diagnosis of osteochondritis dissecans was made and arthrotomy was done April 11, 1921. Incision was made between the olecranon and external condyle. The loose body came into view at once; it was attached by a slender but firm pedicle which had to be cut. The body felt elastic to the finger and was much larger than had been antici-

pated, measuring 3.0 x 2.0 cm. The microscopic examination of this body was of interest in that the bony nucleus seemed to show living bone cells. The elbow has remained well.

COMMENT.

The interest in this case lies chiefly in the fact that it demonstrates definitely the occurrence of osteochondritis in the elbow-joint in a perfectly typical manner.

Most writers on this subject have treated osteochondritis dissecans simply as a phase of the larger matter of loose bodies in joints, rather than as a disease *sui generis;* the reason is rather obvious since most often the symptoms which bring the patient are those of an already liberated loose body. Although Koenig's contention was to the contrary from first to last, there have always been a number who have strenuously insisted upon a traumatism, more or less direct, as the cause. This explanation surely seems the most obvious of any and especially if we are prepared to look upon the trauma as of indirect character. In the face of the very indefinite histories of trauma which we find in nearly all of the cases, and in view of the exceedingly well protected situation in which the lesion is nearly always found, this must be so, of necessity. The force which would result in the breaking out of a segment of the internal condyle of the femur near the intercondylar notch, or of the capitellum humeri, would have to be great beyond the possibility of doubt in the individual case; yet these are the situations in which the condition is seen, almost without exception. On the other hand, we have no record of a kindred process in wrist or ankle; joints which are very commonly and easily subjected to trauma, both direct and severe out of all proportion to anything found in the great majority of the cases with which our discussion is concerned. While not a few cases have been reported in persons who work in a kneeling position, or whose joints may be presumed to have been subjected to severe stresses either in work or play, the history of trauma is most indefinite in an overwhelming majority. The incidence of the condition in the second knee of the same individual in quite a number of instances presents itself as another point arguing for some local peculiarity as a necessary factor. Ludloff reported cases in which it was possible, by means of the x-ray, to recognize the condition so early that when the joint was opened, it was found that the cartilaginous covering of the fragment had not yet become separated from its surroundings and had to be circumscribed by an incision in order to liberate and remove the

bone fragment. I have had this experience in a woman of 50, within the past year; I have not included this case in this series because the x-ray showed evidence of chronic arthritis. As in Ludloff's cases, there was found on the internal condyle of the femur a bluish looking spot in the cartilage which seemed yielding under pressure of an instrument; incision of the cartilage liberated a typical fragment of bone about 1.0 cm. long and 0.3 cm. thick. In this case there was a history of a severe blow against a table about one month before I saw her.

The x-ray appearances of these cases would seem to be very characteristic and significant. The invariable situation on the internal condyle of the femur, the separation of bone leaving a niche in the condyle always of the same general shape and varying only in size, the phenomenon pointed out by Ludloff, all point to some peculiarity of the local circulation as the fundamental factor. The process seems almost inevitably akin to that of infarction as we see it in kidney, spleen, and brain; true, it is not wedge-shaped as are these, but this can be explained by the peculiarity of the local arterial supply to be later referred to. In three of my cases it has been possible to see x-rays of the joint made one year or more after operation; the niche in the bone, while smoothed off at the edges, could be easily seen. This seemed to speak for a peculiar condition of the local circulation; the defect should otherwise have become filled in. In 1908, Ludloff sought to explain the nature of this peculiar disease by a study of the circulation of this part of the knee-joint. He called attention to the work of Lexer, who showed that in childhood the epiphyses of the long bones abound in arteries which are terminal in the same sense that we use this term in viscera, such as kidney, brain, and lung; viscera in which we frequently find the lesion spoken of as infarction. Furthermore, that as development progresses, anastomoses develop quite generally, so that few, if any, vessels may remain as terminal. In the knee, he calls attention to an artery, the arteria genu media, which ramifies over the posterior crucial ligament and the internal condyle of the femur. This artery is frequently a terminal vessel and its blocking could easily explain the occurrence of such a circumscribed necrotic process as we are at present concerned with. Ludloff believed that by simultaneous hyperextension and inward rotation of the joint this vessel would be susceptible of damage by internal trauma. Force of any consequence exerted in this position would, however, be most unusual and could scarcely escape remark. Rieger (*Münch. med. Woch.*, June 15, 1919) observes that fat embolism of terminal vessels in the ends of femur, humerus, and other long bones

has been determined at autopsies. In adults, these terminal vessels run in fat cells, whereas in children they run in connective tissue. He thus explains the failure to observe this condition in children. Granting this, we should, however, be at a loss to explain the occurrence of embolism in these vessels without admitting either an infective or traumatic factor. Of these two, the traumatic would seem much more likely in joints which appear to be in every other respect entirely normal, or at least free from evidence of any other infectious or inflammatory process.

The examination of the radiograms of many knee-joints will show that considerable variations in the formation of the tubercles of the tibial spine are to be observed. Not infrequently they are seen to be much longer than usual, even in the absence of any other visible abnormity in the radiogram. In three of the cases reported here unusual length of these tubercles was evident, and in two of them the internal tubercle was much the longer. For this reason, it seemed worth while to investigate this factor in the cadaver. For this purpose, I was fortunate in securing the coöperation of Dr. Karl Little, Director of the x-ray laboratory of the Cincinnati General Hospital, and Dr. O. V. Batson, Assistant Professor of Anatomy in the University of Cincinnati. The knees of a number of cadavers were first x-rayed by Dr. Little, in order to determine the character of the tibial spines. The knees were then frozen and sawed in coronal section so as to cut through the tibial spine. It was found quite easy, even where the tubercle was not long, to make it impinge upon the posterior crucial ligament when the knee was *flexed and the tibia rotated outwards*. This is just the reverse of the position spoken of by Ludloff. Where the tubercle is long the impingement occurs much sooner, and it seems easily conceivable that it might take place with enough force to damage a small vessel were this to be found just in the right place. The task of producing a vascular blocking in just this situation in the living animal has thus far seemed impossible of accomplishment, and we are, therefore, without further experimental evidence. The position of flexion and external rotation of the tibia is at least one in which the knee is frequently subject to functional trauma, and this observation is therefore simply presented without further comment. While it is conceivable that blocking of a terminal vessel in this situation may occur by reason of embolism, septic or other, just as happens in the viscera, we are without evidence of it in any instance; the endarterial changes described by Freiberg and Woolley in 1910 were, moreover, of inconclusive character. For the present, at least, it would seem as if we

must look upon this interesting condition as the result of trauma, perhaps, but only as an indirect result. The rarity of the lesion is probably to be explained by the necessary concomitance of the several elements:

(a) the existence at this point of terminal arterioles;

(b) a long tubercle of the tibial spine;

(c) internal trauma, occurring in the position of flexion and outward rotation of the tibia on the femur.

There is little need to speak at length of the treatment. Arthrotomy with the removal of *all* loose bodies is our only resource. There is no evidence that further formation of loose bodies ever occurs if the original ones have been removed. This will be most certain if the diagnosis be established early; that is, before the bodies have wandered from the niche in the condyle. We have here another argument for the need of the x-ray in every joint lesion of subacute or chronic character; only thus can identification be made before locking has occurred or a loose body been felt at a point distant from its bed. Experience has shown that for quite a time the loose bodies are attached by a pedicle. Operation thus early may be simple and consist of a short incision, as for loose meniscus. Once the bodies have wandered, the procedure will have to be adapted to the circumstances. It may be desirable to use the transpatellar incision of Jones. I am by no means convinced, however, that this is to be adopted as routine; not because I fear the wider opening of the joint, nor yet because it im[illegible]lie[illegible] a longer and more severe procedure and more protracted conva[illegible]ce. It is rather because I believe that, in spite of its admirable [illegible]posure of the joint, a small body might nevertheless escape detection. In additi[illegible] I have to record one instance in which, notwithstanding perfect [illegible] healing, there ensued a degree of bone proliferation on the po[illegible] aspect of the patella which has constituted a permanent limi[illegible] of flexion movement. While it is true that I was dealing with a chronic arthritis in this case and not with osteochondritis dissecans, the experience has given me food for thought concerning this more complicated form of arthrotomy, useful though I know it to be.

DISCUSSION OF PAPER BY ALBERT H. FREIBERG, M.D.

Dr. H. W. Meyerding, Rochester, Minn.: Dr. Freiberg has covered the subject in his usual thorough manner. As the hour is late and the time limited, I shall show a few x-ray slides and be as brief as possible in my discussion.

I do not believe that we can entirely discard the theory of trauma as an etiologic factor, whether intrinsic or extrinsic. It has been my personal

experience, and, I believe, the experience of others, to have seen patients who have given a clear history of distinct trauma to the knee joint, followed by the formation of loose bodies. These bodies frequently are attached, and at times, as illustrated in slide one, show the cartilage merely cracked loose and lying in its normal position, yet giving rise to pain and discomfort without locking. Later, these bodies, by repeated trauma from joint action, etc., become loose and are still attached by a pedicle. If the border of the cavity from which the body has loosened itself is irregular, particles of cartilage may become loose and give rise to further joint mice. It has been our experience that in time these bodies gradually enlarge in size. If the pedicle is of sufficient size to promote blood supply, this centre of bone may not necessarily be dead, as illustrated in the following sections, which show blood-vessels passing through the pedicle into the osteocartilaginous body. Later when this pedicle is torn, the bony growth ceases, but apparently cartilaginous growth continues until finally it surrounds, in most instances, the bone complete.

The condition is purely a surgical one, and when all loose bodies have been removed and the borders of the crater have been smoothed down so as to prevent particles of cartilage breaking loose, I believe that the result will always be good. However, in operating upon these patients, frequently several small particles of cartilage are found floating in the synovial fluid, and these, I believe, ultimately enlarge and may produce new bodies if not removed. The importance of the x-rays is to be emphasized.

In osteochondritis dissecans we have purely a surgical condition; one in which we get practically 100 per cent. results, and one in which the x-ray plays an important part in the diagnosis.

Dr. R. B. Osgood, Boston: I would like to ask Dr. Freiberg whether he believes these bodies increase in size in the joint, when they are entirely unattached from the synovial membrane. Fisher has suggested that they grow in size [illegible] periods by becoming attached and then becoming redetached. He assumes that growth occurs through the pedicle until they become entirely detached. These bodies have been supposed to grow when perfectly free. The sections suggest that. Considering the nourishment of cartilage to be, not from the blood supply, but from the synovial fluid, I wonder whether Dr. Freiberg had any evidence to indicate that these bodies continue to grow in size when they are free in the joint.

Dr. A. H. Freiberg, Cincinnati (closing the discussion): I felt that my Case 4 was about as good evidence as we could get, even though I must acknowledge that there was a loop hole in the evidence; in other words, this young man came to me with this one body apparently well attached. He had had symptoms before he came. He came to me a year later with this dense body in a different place, four times as large as it was originally. When I removed it, only ten days after I saw it in the joint line, it was way up in the knee, and there was no sign of a pedicle, so that I felt that that was about as good evidence as we were likely to get that such bodies grow in size after they are definitely separated from the original site.

COMBINED CISTERN AND LUMBAR PUNCTURE: AN AID IN THE DIAGNOSIS OF COMPRESSION OF THE SPINAL CORD.*

BY JAMES B. AYER, M.D., BOSTON.

THE communication consisted of a demonstration on a manikin of the hydrodynamic relations within the spinal subarachnoid space, normally, and in conditions of block; together with an estimate of the significance of these findings and of certain chemical tests made on fluids obtained from cisterna magna and lumbar sac.

To the orthopaedist, almost as often as to the internist, neurologist or neurological surgeon, there comes a patient in whom the diagnosis of spinal cord tumor or cord compression from other source is a possibility. In such a case the evidence in favor of some form of degenerative myelitis and of cord tumor is weighed without definite conclusion. Any help to the clinical examination should here be most welcome, and is frequently to be found in a careful study of the spinal fluid, by the method here described.

Spinal fluid findings characteristic of—perhaps pathognomonic for—cord compression were first described by Froin[1] in 1903, and later verified by writers in many countries. Such a fluid is yellow in color, clots on standing, contains a massive amount of protein, and few or no cells; it is usually scanty in amount, and obtained under low pressure. Such a fluid is seldom found except below excessive or rapidly produced compression of the spinal cord. In 1910 Nonne[2] and in 1912 his pupil Raven[3] called attention to the fact that below cord tumors the fluid was more often clear and colorless, and without clot, but contained an excess of protein without pleocytosis. The recognition of this finding—isolated protein increase—became of great value in the corroboration of a diagnosis of probable tumor; but when tumor was thought unlikely, such a finding alone, in that it could not be considered in any sense pathognomonic, could hardly be relied upon.

To render the isolated protein reaction of Nonne of dependable significance in the diagnosis of cord tumor a certain dynamic test was brought forward by Queckenstedt[4] in 1916. This test, independently used by

* Presented at the meeting of the American Orthopedic Association, held at Washington, D. C., May 1-3, 1922

the writer, together with other tests designed to demonstrate blocking of the spinal subarachnoid pathways, supplements the chemical findings and renders a decision as to cord compression much more certain.[5, 6]

The method is briefly as follows:—two needles are placed in the subarachnoid space, one in the lumbar sac, the other in the cisterna magna; a glass manometer of 2 mm. bore is connected with each needle and spinal fluid allowed to flow into each. Certain observations are now made, of greatest significance being the relative change in fluid levels on (1) decrease of pressure, and (2) increase of pressure. The former is readily brought about by withdrawal of fluid, the latter by injection of saline solution, or, better still, because not requiring the introduction of a foreign substance, elevation of intracranial pressure by compression of both jugular veins in the neck. Normally, the fluid falls or rises promptly and equally in both manometers on artificially changing the pressure in either one of the above methods, thereby demonstrating continuity of the spinal subarachnoid space. Abnormally, in the cases under consideration, a rise of pressure at one point will cause no rise at the other; similarly, a drop in pressure will not be accompanied by a corresponding drop in the other. This result indicates spinal subarachnoid block.

It will readily be appreciated that many pathological processes may sever the continuity of the spinal subarachnoid space. The series studied includes demonstrable block in 34 patients, including numerous examples of tumors and abscesses exerting pressure from outside of the dura, of intramedullary tumors causing pressure from expansion outward, and of meningeal adhesions and tumors of the meninges narrowing the subarachnoid pathway. As the determination of block is no indication of the pathological process involved, neither is it evidence as to the localization of the lesion, for in this series block has been demonstrated alike at upper cervical and lower lumbar levels, and loci between.

While the demonstration of a block is the most reliable sign of the existence of some obstructing process, it is likely that transudation of protein about the lesion into the spinal fluid occurs even earlier. On examining fluids obtained from cases of cord compression, the fluid from the lumbar sac has always contained more protein than that from the cistern, frequently ten times, occasionally one hundred times as much.

It will be seen that by this method evidence of spinal subarachnoid block is two-fold: direct evidence of obstruction (hydrodynamic tests), and indirect evidence by chemical tests (hydrostasis). In a correct evaluation of these examinations it has been found that we have a reliable aid in diagnosis—at times earlier than apparently justified by

clinical examination alone—of the various pathologic conditions which cause compression of the spinal cord or constriction of its subarachnoid pathways.

(For a more complete exposition of the method and analysis of findings the reader is referred to two recently published articles.[5, 6])

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FRACTURE OF THE SPINE WITH CORD INVOLVEMENT.*

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The surgery of fracture of the spine with cord involvement may be divided for convenience into two parts, the early and the remote. The early period, the first 24 hours perhaps, is of great importance, as it is during this time that damage to the cord, of a temporary character if relieved, may become permanent, if not so relieved. It is to the problems of this early period that I wish to call your attention.

In the first place let us for a moment analyze the procedures available in the treatment of fractures with cord involvement, and how we can apply them. The operation that immediately presents itself as a possibility is laminectomy. This operation has been criticized as weakening an already damaged spine and has been modified accordingly. Hemilaminectomy has been advocated, but in my hands has proven less satisfactory than complete laminectomy, as the exposure is limited. For the past few years I have used the following technique, fully realizing its limitations. The muscles of the back are dissected away from the spinous processes and laminae on one side only, care being taken to keep close to the bone and wherever possible to pick up periosteum with the muscle. This dissection is carried one vertebra above and one below those of which the arches are to be resected. Next, the spinous processes are cut away from the laminae with heavy forceps, leaving them attached to the muscles on the untouched side and connected to each other and to the spinous processes above and below by the interspinous ligaments. The dissection is then carried down along the laminae of the opposite side until the arches are completely exposed. This procedure is very similar to that advocated by Dr. Gaenslen[1] in a paper read before this Society in 1917, the salient feature being the preservation of the spinous processes and their ligamentous attachments, and I agree heartily with Dr. Gaenslen on the importance of saving these structures. The laminae are removed with rongeurs, all bone chips being preserved for future use. The various procedures indicated in a given case, such as removal of clot or indriven fragments of bone, reduction of deformity, longitudinal section of the cord and the like, are now carried out. The articulations, if not already destroyed, are

*Presented at the meeting of the American Orthopedic Association, held at Washington, D. C., May 1-3, 1922.

now crushed and bone chips laid in between the stumps of the laminae on both sides with the idea of strengthening the damaged spine. The muscles are sutured to the interspinous ligaments, and the fascia and skin closed.

I have cut down a second time on one case treated in this way and was much pleased to find an almost continuous strip of bone on each side. The result, though not as strong as that of a fusion operation or a bone graft, must be stronger than that following the usual laminectomy.

Other operative measures which may be indicated are the fixation operations, either by bone graft or fusion, or more rarely by simply passing a wire or silk ligature about the spinous processes. The application of the fixation without laminectomy is more often indicated in the late case, but is occasionally of value soon after injury. Closed or open reduction of deformity without laminectomy is seldom indicated in the presence of cord lesion, except in fracture-dislocation of the cervical region. A discussion of the technique of fixation or reduction before this Society is out of place and so will be omitted. I think we can all agree that a carefully performed laminectomy, with proper effort to prevent a weakened spine, is the operation which will most frequently be performed.

I have summarized briefly as follows the pathological conditions which result from trauma, and the treatment I consider appropriate in each instance. With this summary as a starting point we can take up the individual lesions with an eye to the difficulties in diagnosis.

CHART 1.

Laminectomy.	Fixation Only.	No Operation.
Crush of the cord without loss of continuity.	Free fracture with slight cord involvement.	Severed cord. Crush of sufficient severity to prevent any recovery.
Intradural hemorrhage.	Fracture with increasing kyphos and slight cord involvement.	Hematomyelia.
Extradural hemorrhage.		Slight oedema or extravasation of blood.
Severe oedema.		
Deformity of the spinal canal causing angulation and compression.		
Severe injury to the cauda equina.		

The second group, those demanding fixation, is easily recognized and can be passed over with a word. To my mind such a case should receive adequate fixation, namely, a graft and plaster jacket. If there is a kyphos, an attempt may be made to reduce the deformity by traction before the graft is applied. If there is a free fracture, the problem is a little different and no definite form of fixation can be laid down. One case will be treated by a graft and the next will require suture of laminae or spinous processes.

The other two groups cannot be disposed of so easily, as the differentiation of the lesions enumerated is frequently difficult or impossible. If the fracture is below the cord and the cauda equina alone is involved, laminectomy is indicated unless the symptoms are slight and tend to subside rapidly. The time factor is less important here than in lesion of the cord itself and even in late cases marked improvement may be looked for from relief of pressure. For this reason it is wise to delay until examination reveals which roots have been permanently damaged. Motor roots if severed should be sutured, but the suture of sensory roots is useless.

Fractures with little deformity and slight injury to the cord, especially if there is subsidence of symptoms, require no operation, a plaster shell and recumbency being adequate treatment at first. Such a case probably represents a moderate amount of oedema of the cord with, possibly, some extravasation of blood. I have placed hematomyelia in the group of lesions in which operation is not indicated, but I must admit I have some misgivings in so doing. A clot within the substance of the cord is as much a foreign body as if present elsewhere and I should not be greatly surprised to find its evacuation advocated in the near future. Of course such a clot usually extends for several segments up and down the cord, making its evacuation a very serious problem. I consider the prognosis for complete recovery in untreated hematomyelia to be more than doubtful. Paralysis of the Brown-Séquard type is indicative of hematomyelia and is, if we accept the above, a contraindication to operation.

We can feel pretty sure of our ground for and against surgical intervention in the groups of cases so far enumerated, but unfortunately we have left a large group in which the diagnosis will be more doubtful, as each and all of them may present the same clinical picture. This group comprises on the one hand partial crush of the cord, many cases of extra-medullary hemorrhage, contusion, and severe oedema, all demanding surgical treatment; while on the other hand we have complete cord section, irreparable crush, many cases of hematomyelia and

a number of cases of mild contusion or oedema with grave initial symptoms, in all of which operation is useless. All the pathological conditions here enumerated may and frequently do present the symptoms of a complete lesion. We have all seen patients with abolished reflexes, complete motor and sensory paralysis, and so forth, go on to ultimate recovery.

The war has given us positive evidence reported by many observers that patients with complete cord section may develop, at a later date, marked reflex activity and complicated defense movements. The defense movements may be of such a character as to give rise to the erroneous belief that regeneration of the cord has taken place. While not applicable to the early case, this refutation of Bastian's Law,[2] accepted as a fact by the writers of fifteen years ago, shows the importance of recent progress in neurology. If, then, it is so difficult to differentiate between the severe and the mild types of injury, what are the indications for operation. Numerous writers, both in this country and abroad, have stated in very positive terms that the only cases suitable for operation are those in which the symptoms point to a partial lesion only and that operation should only be performed after a sufficient interval of time has elapsed to prove this partial lesion and that spontaneous recovery will not take place. To my mind this attitude, though conservative, must abandon, as hopeless, a certain number of cases in which operation would be of benefit.

Dr. A. R. Allen[3] in a classical piece of experimental work on animals found that, even if sufficiently bruised to cause permanent paralysis, the cord would recover if a median longitudinal section was performed within a few hours of the time of injury, thus permitting the escape of oedema from the cord. This work was most painstakingly carried out. He used a contrivance like a miniature pile-driver to give the blow to the cord and so could measure the impact in gram centimeters. An impact far greater than that required to cause permanent paralysis was given directly to the cord after laminectomy had been performed and then after a delay of two or more hours the cord was split, the wound closed, and the animal allowed to recover. The period of convalescence was long in some cases, but the fact of recovery of function was amply proved. Where longitudinal section of the cord was postponed for six hours even, there was more destruction of the tissue than in the animal whose cord was sectioned in two hours. To my mind, this work is of the greatest importance in the problem in hand. It gives us a direct means of reducing the pressure within the cord and

of draining serum, extravasated blood, etc., and also proves that delay is dangerous.

Frazier[1] gives much credit to Allen for his work. His conclusions are too long to be quoted here, but are most valuable reading for anyone interested in this subject. He states:

"There is a prevailing sentiment that a complete transverse lesion is in itself a positive contraindication of operation. To maintain this attitude one must assume that the symptoms of a complete transverse lesion invariably indicate an irreparable damage to the cord. Clinical experience, however, does not bear this out. I have come to disregard the clinical picture of a complete transverse lesion *per se* as a contraindication to operation." And later: "If operation is to be performed at all it should be done at the earliest possible moment."

My own rules are as follows: Consider every fractured spine with cord involvement a surgical emergency until it is satisfactorily demonstrated that operation is not indicated. Any case showing increasing symptoms should be operated on at once or as soon as the patient has sufficiently recovered from shock. If at first examination it cannot be determined whether or not the lesion is progressive, the findings are carefully noted, particularly the sensory changes, and shock treatment instituted. A few hours later the patient is again examined and a third time if necessary. If symptoms have increased, laminectomy is indicated. If they have decreased, it is contraindicated.

This will still leave a considerable group undecided, as most cases with complete paralysis from the beginning will show no change whatever. If from the history, local or x-ray examination, it seems certain that the lesion is a complete crush, operation is contraindicated. If a pure hematomyelia, the same is true. (I have yet to see a case in which I could feel at all sure of the diagnosis of hematomyelia within the first 24 hours.) If the cord damage is slight enough to make it probable that regression of symptoms will take place, operation is contraindicated. I fully realize that this last statement is vague and unscientific and leaves much to be desired, but it is as near as I can come to anything exact. If the signs of complete section are present but not borne out by history, local examination, or x-ray, laminectomy should be performed in the hope of finding some remediable lesion, though the chances of improvement are slight. If there is evidence at this time of marked angulation or any other cause of direct compression and yet not enough to warrant a diagnosis of complete transsection, operation is indicated. If there is evidence of damage to the cord, other than complete section sufficient to cause total disability, should it persist, operation is indi-

cated. Lesions of the cauda equina may be left for some time before operation is finally decided upon, but where the cord itself is damaged, a definite course should be mapped out within the first 24 hours. As Allen has shown, operation after that time has passed is of much less value and I consider late operation to be justified only in unusual circumstances.

CHART 2.

	Total.	Improved.	Unimproved.	Died in Hospital.
Laminectomy	16	4	6	6
Transsection	2			
Crush or oedema	11			
Hemorrhage	2			
No lesion found	1			
Fixation only (no operation)	3	3	0	0
Slight cord involvement (no operation)	25	22	3	0
Apparent transsection	9	2	3	4
Total	53	31	12	10

Note:—In 4 cases of this series a longitudinal incision was made in the cord, but in only one was there any improvement. I think it is fair to add that in all the 4 cases the cord was very severely damaged—much more severely than in those cases in which cordotomy was omitted.

Following this scheme at least four definite errors are shown in my group of cases; two at operation showed complete section and two in which operation was not advised, on the ground that complete section existed, ultimately showed definite though incomplete restoration to function. (Thus emphasizing the point that clinical evidence of a complete section may be deceptive.) Of the sixteen laminectomies only four showed relief of symptoms and in all of these the critic can say "Would these patients not have done as well without operation?" In one, he probably would be right (no lesion found); in the other three, in my opinion, operation was of value, though there is no definite proof.

There is no doubt that the results of surgery of trauma of the cord can be improved in several ways. First, by improvement in our operative procedure. We need a wide laminectomy combined with easy, rapid, and immediate fixation. In such critical cases the extra time and manipulation required for a tibial graft is almost invariably out of the question. Perhaps fixation with beef bone can be utilized. Second, speed in all the preliminaries, immediate neurological examination, x-ray examination, institution of shock treatment, and then a review of the neurological findings to demonstrate any changes. All this to be

done within the first few hours. Third, a more careful routine examination of the cerebro-spinal fluid by lumbar puncture or by combined puncture of the lumbar space and the cisterna magna. This examination should include in every instance pressure readings, evidence of block, presence of proteid or of blood. A series of such examinations with the subsequent findings in each case might give us data that would go far toward solving our problem. Lastly, the war has provided a wealth of neurological material which is only now beginning to be available. Methods of neurological examination and interpretation of results are improving and we must see to it that our neurological consultants apply these improvements.

I have tried in this paper to limit myself to the general consideration of this subject and have omitted almost all mention of special conditions and already solved problems, and have devoted my attention to what may be called the doubtful case.

To my mind the time is already past and gone when a surgeon has reason to say: "You must simply make up your mind to operate on all or none." We can pick our cases and we can do it with some degree of success. Closer attention to detail and a further striving for new light on our part will eventually dissipate, to a considerable extent, the shadow which hangs over the man with a broken back.

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CRUSH FRACTURES OF THE SPINE.*

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THE object of this communication is to present to you a study of 82 cases of fracture of the spinal column, of which a great majority had been unrecognized and consequently untreated, causing a great deal of unnecessary pain and disability as well as a great economic loss to the community.

The spinal column is a flexible tube whose outline varies with every movement of the body. It supports the head and trunk, and maintains the body in an erect posture. The spine has an anterior support, the vertebral bodies and intervertebral discs, and a posterior support, the articulations. Of these, the posterior supports are the most important, for a lamina may be removed and the vertebral body crushed, and yet one may stand erect.

Fracture of the spine results from direct violence and indirect violence. The most frequent cause is indirect violence, in which there is a hyperflexion, a hyperextension, or a shortening of the longitudinal axis of the column beyond the limits of its elasticity.

Fractures in which hyperflexion or hyperextension are the agents are more common in regions where a more fixed portion of the spine meets a movable portion, as in the dorso-lumbar or dorso-cervical portion.

Fractures in which shortening of the longitudinal axis takes place are in the fixed regions and are usually the result of indirect action; the articulating processes are first crushed.

In indirect fracture of the spine—there is generally crushing of the bodies, rupture or sprain of the posterior ligaments and muscles, rupture or sprain of the anterior ligaments, dislocation and rotation of the vertebrae.

TYPE OF INJURY IN 82 CASES.

In six cases the method of injury was not given, leaving 76 cases.

In nine cases the history of the injury gave no definite forcible flexion of the spine and the mechanism of the fracture could not be determined.

This leaves 67 cases in which a definite history of forcible flexion of the spine was given. These cases can be divided into three different

*Read at the meeting of the American Orthopedic Association, held at Washington, D. C., May 1-3, 1922.

Plate No. 1.—Showing side view of spine with deformity as taken in the ordinary way.

types according to the manner in which the forcible flexion was accomplished.

Type I.—In which some heavy object fell from above, alighting on the patient. Most of these cases were falls of slate or roof coal in the mine, and generally struck the patient when the spine was already slightly flexed from his position in working. In most cases the patient told of being doubled up and in quite a few cases stated that "his head was forced between his legs."

Type II.—In which the patient fell from a height, striking the ground on head and shoulders. Among these cases were falls from trestle, tipple, scaffold, buildings, house, wagon, elevator shaft, and in diving and striking head on bottom or projecting shelves.

Type III.—In which patient was squeezed between two objects, causing slow forcible flexion of the spine; as a farmer driving a load of hay into a barn was squeezed by jamb of door and hay.

Notenda.—In one case the patient gave a history of lifting a mine car back on the track, which he accomplished and says he "felt something give in my back."

PLATE NO. 2. Showing side view of the spine with the legs flexed on the abdomen to hold the lumbar spine straight, thus throwing the deformity in the upper fragment. This is the proper way to take an x-ray picture in order to determine how much deformity really exists in a spine.

Of 67 cases of forcible flexion:—

Type I	45 cases
Type II	17 cases
Type III	5 cases

In every case in which the history showed a patient was caught in a flexed position and had spine flexed so that head was forced between legs, a fracture of one of the lower vertebrae was found.

AGE, SEX, AND OCCUPATION.

Age.—Out of 82 cases, the age was not given in 18 cases, leaving 64 cases. Youngest case was 16 years. Oldest case was 65 years. Average age was 39 years. Below 40 years there were 35 cases. Above 40 years there were 29 cases.

PLATE No. 3.—Showing side view of the spine with the dorsal spine held straight, thus throwing all the deformity in the lower fragment or lumbar spine. This is the position in which the patient is placed on the frame for application of a body cast.

Age by decades:

Below 20 years	4
20 to 30 years	14
30 to 40 years	17
40 to 50 years	12
50 to 60 years	11
Over 60 years	6

Sex.—Most of the cases represent industrial casualties and naturally are nearly all males. The few cases of females represent the percentage of ordinary accidents seen in private practice.

82 cases below show male 78—female 4.

Occupation.—In 12 cases the occupation was not given and in five cases the patient had no occupation, leaving 65 cases.

Most of our cases are coal miners, an industry in which forcible flexion of the spine from falls of slate, roof coal, etc., is a very common occurrence.

PLATE No. 4 Showing a new frame on bed with screw in end by which it is elevated. Shows corrugated top in two pieces, the one sliding over the other to accommodate different sizes of patients and different sites of deformity. In this position, it can be used as a fracture board. Note the cradle on end of frame, to which the feet are tied

In 65 cases, 46, or 71%, were coal miners.

Among others were laborers, structural iron worker, railroad brakeman, carpenter, baker, clay miner, painter, driver, coke worker, moulder, elevator girl, rigger, farmer, farm superintendent, and platform man for express company.

Previous Diagnosis and Elapsed Time When Seen by Us.—In 8 cases, the question of previous diagnosis was not given. In 7 cases, charge was assumed immediately. This leaves 67 cases. Diagnosis not made previously—47 cases. Diagnosis made previously—20 cases.

It is interesting to note that in 20 cases in which a diagnosis of fracture of the spine had been made previously, 15 cases, or 75%, had paralysis. In the 47 cases in which no previous diagnosis had been made, only 3 cases, or 6%, had any paralysis, and two of these consisted merely of weakness of isolated muscles.

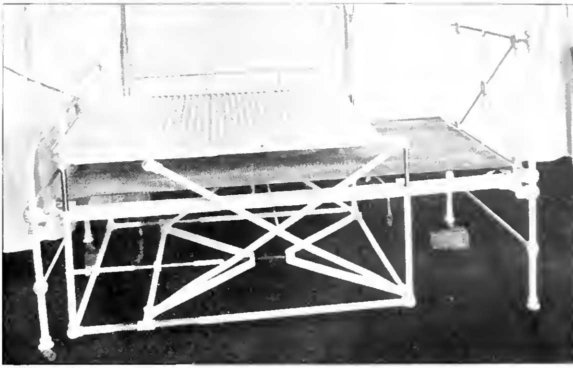

PLATE NO. 5.—Showing the frame raised about seven inches.

In 10 cases elapsed time was not given. In 7 cases charge was assumed immediately. This leaves 67 cases. Averaged elapsed time 373 days.

In the 47 undiagnosed cases, the shortest time elapsed since injury was 25 days and the longest period of elapsed time was 1045 days. Averaged elapsed time 311 days.

ASSOCIATION WITH OTHER INJURIES OUTSIDE OF SPINE.

In four cases not given in record. This leaves 78 cases. No injuries outside of spine — 55 cases. Injuries outside of spine — 23 cases.

Analysis of Other Injuries:

Fracture of Ribs	11 cases
Fracture of Tibia and Fibula	6 cases
Fracture of Femur	3 cases
Fracture of Skull	2 cases
Fracture of Clavicle	2 cases
Fracture of Humerus	2 cases
Fracture of Pelvis	1 case
Fracture of Acetabulum	1 case
Fracture of Radius and Ulna	1 case
Fracture of Tarsals and Metatarsals	1 case

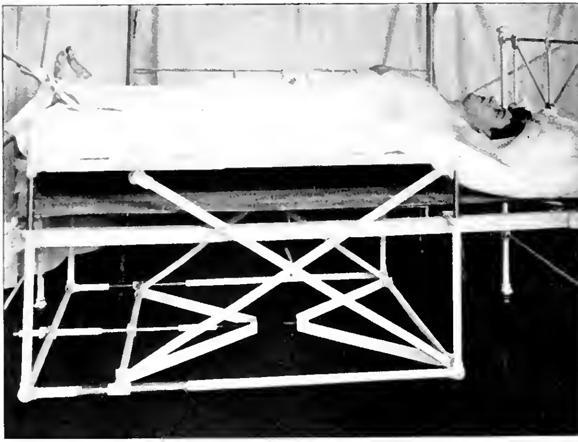

PLATE No. 6.—Showing the frame in use. Note the patient tied to the frame with glued stockinette. Notice the lower fragment parallel and the upper fragment hyperextended. Notice also the position of the chest, the wide costal angle and the abdominal viscera up in proper position.

Dislocation of Shoulder	1 case
Dislocation of Internal Semilunar	1 case
Rupture of Crucial Ligament of Knee-joint	1 case

Notenda:—Two cases are worthy of special note—*viz:* in one of which the patient sustained a fracture of the first rib on both sides (2nd dorsal vertebra crushed) and one who had a dislocation of the internal semilunar cartilage, left knee, which had been the chief disability from the patient's standpoint ever since injury (1st lumbar vertebra crushed).

ASSOCIATION WITH OTHER INJURIES OF THE SPINE.

In one case no x-ray was obtainable. This leaves 81 cases. Fracture of the transverse processes was the most common injury. This occurred on either one or both sides and of the vertebra crushed; sometimes the vertebra above and below. Fracture of the spinous processes was rather rare, having occurred in only three of our cases. Fracture of the articular processes occurred in one case. Total 81 cases:

PLATE No. 7.—Showing the patient in proper position on the frame for the application of a new type of body cast. Note that the dorsal spine representing the upper fragment is in a perfect horizontal position, while the lumbar spine representing the lower fragment is allowed to arch forward.

Fracture Transverse Processes......................18 cases
Fracture Spinous Processes........................ 3 cases
Fracture Articular Processes...................... 1 case

COMPLAINTS OF PATIENTS.

Pain.—No data on 22 cases, leaving 60 cases for statistics. In half the cases the patients not only had pain in the back, but also had pain referred to other parts, generally the legs, also to hips, chest, abdomen, head, etc. In a few cases they had no pain in back, but had referred pain. In a few cases they had no pain whatever.

Pain in back, also referred pain........30 cases out of 60, or 50%
Pain in back alone.....................20 cases out of 60, or 33 1-3%
Referred pain only..................... 4 cases out of 60, or 6 2-3%
No pain at all......................... 6 cases out of 60, or 10%

Pain in back — 50 cases out of 60 — 83 1-3%
No pain in back — 10 cases out of 60 — 16 2-3%

Other Complaints of Patients:

1. Paralysis or weakness of legs in all cases with paralysis — 23 cases.
2. Loss of bowel or bladder control when present — 8 cases.
3. Sensory disturbance — 4 cases.
4. Weak back — 16 cases.
5. Stiff back — 13 cases.

PLATE No. 8. Photograph showing new type of body cast with the window cut out in the back just below the point at which the spine deforms. During application of the cast, the spine was held with the dorsal spine horizontal and allowing the lumbar spine to arch forward. The position of the spine as shown in Print No. 3, lateral x-ray view of the spine. The position on the frame for application of the cast is shown in Print No. 7.

PLATE No. 9.—Showing an old fracture crush before treatment. Notice the prominent spines and the flexion deformity.

6. Cannot straighten back — 8 cases.
7. Cannot lift — 6 cases.
8. Shortness of breath — 3 cases.
9. Loss of sexual power — 2 cases.
10. Nervousness — 3 cases.

DEFORMITY.

No data on 24 cases. This leaves 58 cases for statistics.

In all the cases but 2 (fracture of the 5th lumbar vertebra), the spinous processes were prominent, making localization of fracture possible before radiography. The two fractures of the 5th lumbar vertebra had an increased lumbar lordosis.

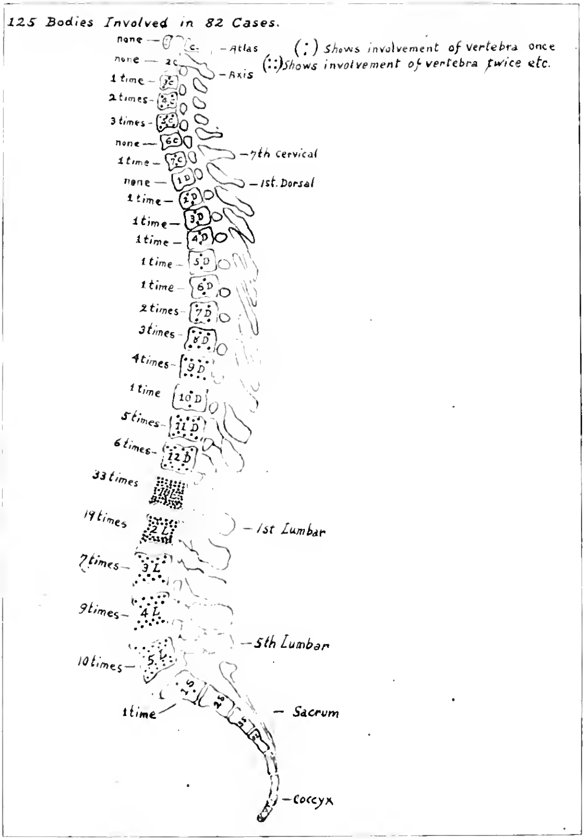

Plate No. 10 — Fracture crush of vertebral bodies (82 cases). Diagram showing the relative frequency of fracture involving the various individual vertebrae.

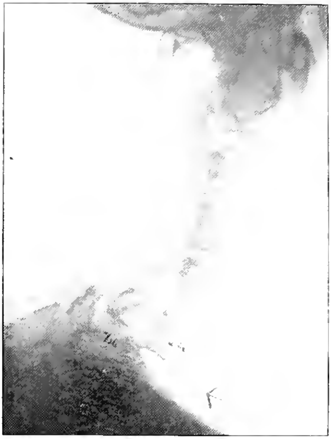

PLATE No. 11.—55. Mr. V. W. Age 50 years. Diving, struck head on stone shelf. Paralyzed from neck down. Fracture on the anterior upper quarter of 7th cervical vertebra with 6th cervical vertebra forward and posterior edge of 6th cervical fitting in step on 7th cervical.

In 12 cases, no deformity was present, but the spinous processes of the fractured vertebra were prominent.

In some cases, a kyphosis was present alone; in some a scoliosis, and in others they were combined. In two cases, a rotation deformity alone occurred.

Deformity present in 46 cases out of 58 cases — 79%.

Kyphosis	28 cases
Scoliosis	20 cases
Rotation	2 cases
Lordosis	2 cases
Flexion Cervical Spine	4 cases

Posture.—In some cases the fracture was grafted on a poor posture.

Notes on Posture:—

Round shoulders, visceroptosis, hollow back	6 cases
Round shoulders, visceroptosis, flat back	3 cases
Round shoulders alone	2 cases
Hollow back alone	2 cases
Flat back alone	6 cases

PLATE No. 12.—62. Mr. J. W. Age 32. Platform Expressman. 150 lb. box fell off wagon on head and shoulders. No paralysis. Shows moderate crush of 4th and 5th cervical.

DISLOCATION OF VERTEBRAL BODY.

1. Lateral Dislocation.—In 25 cases out of 81 lateral dislocation present—31%.

2. Anterior Dislocation.—In 5 cases out of 81 anterior dislocation present—6%.

3. Posterior Dislocation.—In 4 cases out of 81 posterior dislocation present—5%.

In 2 cases paralysis both legs.
In 1 case (78) no data on paralysis.
In 1 case no paralysis present.

LIMITATION OF MOTION.

No data on 24 cases. This leaves 58 cases for statistics.

In all the cases there was some limitation of motion present. In no case was a note made that no limitation of motion was present, but in 6 cases out of 58 there was only slight limitation.

In nearly all the cases extension of the spine was the motion most

Plate No. 13. —81. Mr. D. M. Age 24. Walked off a trestle in dark 30 or 40 feet high. Was in two different hospitals for observation. No diagnosis made. Came in complaining that he couldn't get his breath and had pain in back. X-ray shows a crush of the 9th and 10th Dorsal. Antero-posterior view shows a lateral dislocation of the 10th Dorsal vertebra to left on 9th.

restricted. In a vast majority of cases, normal hyperextension of the spine was impossible either actively or passively. Lateral bending was also restricted in most cases. In most cases forward bending was freer than other movements and in all cases, except those with a marked lumbar lordosis, forward bending was not restricted to any marked degree.

Muscle Spasm.—Except in early cases, which are in the minority in this series, muscle spasm was usually not present, and when present, was only slight.

No data on most cases. Recorded as present in 22 cases. Recorded as slight in 4 cases. Recorded as absent in 10 cases.

Hamstring Spasm.—No data on most cases. Recorded as present in 13 cases. Recorded as absent in 8 cases.

TENDERNESS ON PRESSURE.

Grasping the spinous process of the fractured vertebra between the fingers and exerting deep pressure produced a deep bone tenderness

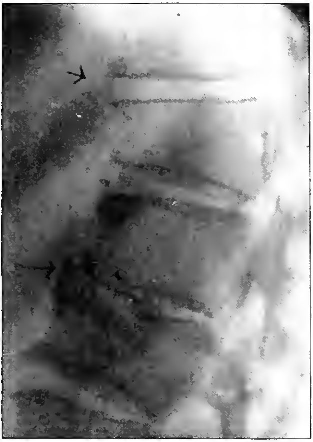

PLATE No. 14. 49. Mr. J. P. Age 49. Moulder. Eighteen ton casting fell on him, crushing him down into moulding sand, burying him. Fracture of right femur. Back unrecognized. Moderate crush of 2nd lumbar and slight crush of last two Dorsal and 1st and 2nd Lumbar. Bone Bridge anteriorly between 1st and 2nd lumbar. X-ray taken after treatment.

comparable to the tenderness of callus, while still soft, in the healing fractures of long bones, or is due to pull of ruptured or strained ligamentous attachments on the spinous process. This was found present in all early cases and in most late cases. It seems to leave under treatment as the repair occurred in the crushed vertebrae.

No data given on 50 cases. Marked present in 28 cases. Marked absent in 4 cases.

Notenda:—In four patients having no tenderness, three of them were of 1 to 2 years' standing before examination, and the other had a fracture of the 5th lumbar, with the symptoms all referred to the left leg.

PARALYSIS.

No data on paralysis on 4 cases. This leaves 78 cases.
Paralysis present in 23 cases. No paralysis present in 55 cases.
Paralysis present in 23 cases out of 78, or 30%.

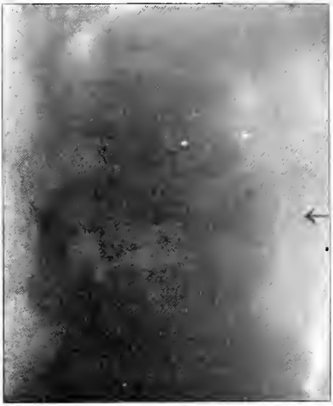

PLATE No. 15.—39. Mr. E. W. Age 60. Coal Miner. Fall of slate. Hour glass contraction of 2nd Lumbar, the first Lumbar being the causative factor. Shows a very severe flexion must have taken place in order to produce such a deformity.

Extent of Paralysis.—1.—Both legs, 13. 2.—One leg, right, 4; left, 5; total 9. 3.—Both arms and both legs, 1.

Anesthesia noted present in 9 cases.

Bowel and Bladder disturbances noted present in 8 cases.

Reflexes: Noted increased in 20 cases. Noted decreased or absent in 9 cases.

Effect of Age on Paralysis: Number of cases where age and paralysis were given — 15 cases.

Age under 40 years — 8 cases
Age over 40 years — 7 cases

By Decades: —

Under 20 years	0 cases
20 to 30 years	5 cases
30 to 40 years	3 cases
40 to 50 years	2 cases
50 to 60 years	5 cases
Over 60 years	0 cases

Apparently no influence in any of the above cases.

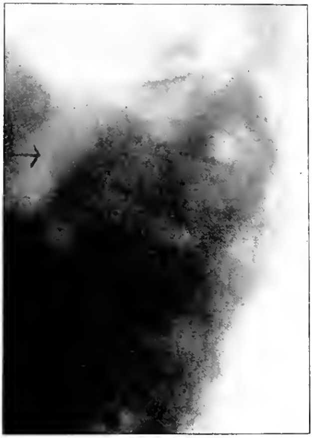

PLATE NO. 16.—27. Mr. J. L. Aged 30 years. Mine Foreman. Fall of slate; untreated. Seen 87 days after accident. Had flexion deformity of 45 degrees with a right dorsal left lumbar scoliosis. Side view shows the wedging of the first Lumbar and healing between the antero superior surface of the 1st Lumbar and the inferior surface of the 12th Dorsal. This man was corrected. The correction was of posture and not at the site of fracture which was firmly united when seen.

Effect of Type of Injury on Paralysis.—In 67 cases of Types I, II, and III, there were 20 cases of paralysis, or 30%.

Type I.—14 cases out of 45 cases, 31%. No influence. Type II.—5 cases out of 17 cases, 29%. No influence. Type III.—1 case out of 5 cases, 20%. No influence.

Effect of Vertebra Involved on Paralysis.—In 23 cases out of 81 cases, paralysis occurred.

1st Lumbar—10 cases paralyzed out of 33 cases where 1st lumbar involved—30%.

2nd Lumbar—4 cases paralyzed out of 19 cases where 2nd lumbar involved—21%.

4th Lumbar—4 cases paralyzed out of 9 cases where 4th lumbar involved—44%.

3rd Lumbar—2 cases paralyzed out of 7 cases where 3rd lumbar involved—29%.

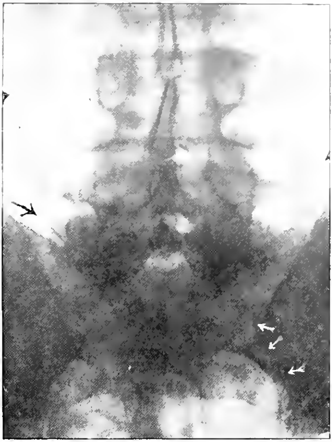

Plate No. 17.—28. Mr. I. L. Aged 53. Fracture Crush 5th Lumbar. Dislocation of 4th on 5th to left. Fracture of the left ala of sacrum. Fracture of the transverse processes of the 4th and 3rd Lumbar; both sides.

5th Lumbar—1 case paralyzed out of 10 cases where 5th lumbar involved—10%.

7th Cervical—1 case paralyzed out of 1 case where 7th cervical involved—100%.

4th Cervical—1 case paralyzed out of 2 cases where 4th cervical involved—50%.

9th Dorsal—1 case paralyzed out of 4 cases where 9th dorsal involved—25%.

11th Dorsal—1 case paralyzed out of 5 cases where 11th dorsal involved—20%.

Location of Fracture.—Based on 81 cases. In majority of cases, a single vertebra was involved. Single body crushed, 60 cases. More than one body crushed, 21 cases. The only individual vertebrae not involved in this series were the 1st and 2nd cervical, 6th cervical, and 1st dorsal vertebrae. In one case, the 1st sacral segment had been crushed.

Following is the involvement of the individual vertebrae in order of frequency: 125 vertebrae crushed in 81 cases.

PLATE No. 18.—73. Mr. G. K. Driving a hay wagon, caught between the top of the door and the hay. Two wedge-shaped vertebrae. Pressure equally applied above and below. Example of Type 3.

1	Lumbar	33 times	— 41%
2	Lumbar	19 times	— 23%
5	Lumbar	10 times	— 12%
4	Lumbar	9 times	— 11%
3	Lumbar	7 times	— 9%
12	Dorsal	6 times	— 7%
11	Dorsal	5 times	— 5%
9	Dorsal	4 times	— 5%
8	Dorsal	3 times	— 4%
5	Cervical	3 times	— 4%
7	Dorsal	2 times	— 2%
4	Cervical	2 times	— 2%
3	Cervical	1 time	— 1%
7	Cervical	1 time	— 1%
2	Dorsal	1 time	— 1%
3	Dorsal	1 time	— 1%
4	Dorsal	1 time	— 1%
5	Dorsal	1 time	— 1%
6	Dorsal	1 time	— 1%
10	Dorsal	1 time	— 1%
1	Sacral	1 time	— 1%

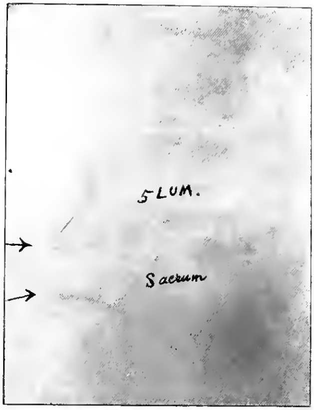

PLATE No. 19.—66. Mr. John A. Miner. Age 39. Lifting a coal car on a track, foot slipped and lifting it again felt something give in his back, causing him to fall to the ground. X-ray shows a crushing of the anterior inferior surface of 5th Lumbar; anterior superior surface of sacrum, with marked spur formation.

12th Dorsal,—1st and 2nd lumbar involved in 48 cases out of 81 cases, or 59%. Lumbar vertebrae crushed 78 times out of 125 times, or 62%. Last 7 vertebrae (11th and 12th Dorsal and Lumbar) crushed 89 times out of 125 times, or 71%.

Effect of Age on Location of Fracture.—Under 40 years of age—1st Lumbar involved 18 times in 34 cases, or 53%. 12th Dorsal—1st or 2nd Lumbar involved in 22 cases out of 34, or 65%. Over 40 years of age—1st Lumbar involved 7 times in 29 cases, or 24%. 12th Dorsal—1st or 2nd Lumbar involved in 10 cases out of 29, or 34%.

By Decades: Under 20 Years.—Total cases. 1st L. involved 2, or 50%. 12th D.—1st L. 2nd L. 3, or 75%.

20-30 Years.—Total cases 13. 1st L. involved 7, or 54%. 12th D.—1st L. 2nd L. 10, or 77%.

30-40 Years.—Total cases 17. 1st L. involved 9, or 53%. 12th D.—1st L. 2nd L. 9, or 53%.

40-50 Years.—Total cases 12. 1st L. involved 4, or 33 1-3%. 12th D.—1st L. 2nd L. 6, or 50%.

PLATE No. 20.—24. Mr. L. Z. Coal Miner. Fall of slate; paralysis of left leg. Had laminectomy done. Complains of weak back and paralysis of left leg. Crush of 1st Lumbar by 2nd Lumbar. Right articulating surface of 12th Dorsal vertebra crushed off. Dislocation of 2nd Lumbar to right on 1st. Shows lateral bone bridges between 1st and 2nd Lumbar on both sides, and dense healing.

50-60 Years.—Total cases 11. 1st L. involved 3, or 27%. 12th D.—1st L. 2nd L. 3, or 27%.

Over 60 Years.—Total cases 6. 1st L. involved 0, or 0%. 12th D.—1st L. 2nd L. 1, or 17 %.

1st Lumbar Involved.—Type I, 16 in 45, or 36%. Type II, 7 in 17, or 41%. Type III, 3 in 5, or 60%.

12th D.—1st L. 2nd L. Involved.—Type I, 25 in 45, or 56%. Type II, 9 in 17, or 53 %. Type III, 3 in 5, or 60%.

PREVIOUS TREATMENT.

No data on 12 cases. Seen in consultation 1 case. Under care immediately — 5 cases.

This leaves 64 cases for statistics. Received previous treatment of back—18 cases. Received *no* previous treatment of back—16 cases.

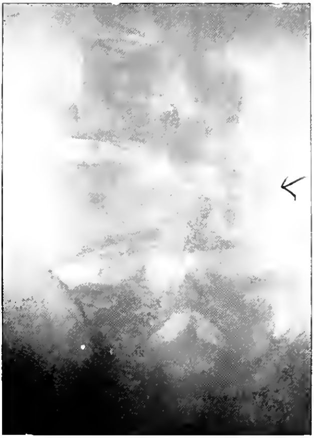

PLATE No. 21.—37. Mr. John H. Aged 22. Coal Miner. Fall of slate; paralysis of both legs five weeks. Antero posterior view shows rotational deformity with dislocation of 4th Lumbar to left and crushing of 4th Lumbar on right side.

Other treatment received—Laparotomy, 1 case. Laminectomy, 4 cases.

Treatment with appliances (cast or brace), 8 cases.

CAUSATIVE FACTOR.

In studying the x-ray plates it was seen that while in most cases the vertebra above was the implement by which the force was applied to the vertebra crushed, in 20% of the cases the force seemed applied from below upward by the vertebra below.

BONE BRIDGE IN HEALING.

The presence of bone bridges extending from one vertebra to another were noticed in the healing process. Sometimes the bridge was anterior, sometimes lateral, and sometimes they formed both anteriorly and laterally. In most cases the bone bridge was growing from the vertebra crushed to the one which appeared to be the causative factor in the

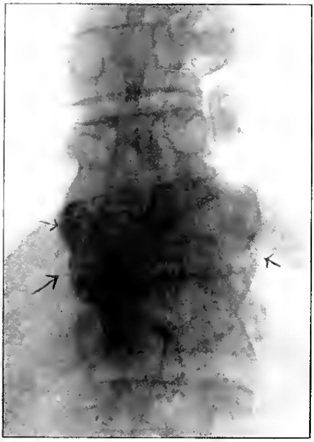

PLATE No. 22.—57. Mr. G. F. Aged 57. Laborer. Fell twelve feet from porch roof, lit on shoulders, head between legs. Angular deformity. Crush of 11th Dorsal, more on the right side laterally. Dislocation of the 11th Dorsal to the left on the 10th Dorsal, showing dense healing and lateral bone bridges.

crushing. In 6 cases (23)—(25)—(38)—(57)—(60)—(64), the bone bridge had grown from the vertebra above the fractured one to the vertebra below the one fractured right across the crushed vertebra.

Cases showing bone bridge, 27 cases — 33%. Cases not showing bone bridge, 54 cases — 67%.

Variety of Bridge Shown.—Anterior bone bridge, 17 cases. Lateral bone bridge, 14 cases. Bone bridge across crushed body, 6 cases.

TREATMENT, DIVIDED INTO EARLY AND LATE.

Mechanics of Treatment.—In examining a fractured spine—especially the late cases, in lateral bending—you will find a point at which the upper fragment and lower fragment pivots. This pivot is at the site of the fracture, and will be at a point around the most prominent spinous process. This can be readily seen in a series of three lateral views of a case of tuberculosis of the spine.

PLATE No. 23.—36. Mr. R. M. Coal Miner. Fall of slate, producing a flexion of the spine. Triangular crush of the 1st Lumbar with posterior dislocation of the 1st Lumbar. Paralysis of bowels and bladder which is still present. Paralysis of both legs, which has cleared up.

Plate No. 1.—Showing the kyphosis with the deformity equally distributed above and below the kyphosis.

Plate No. 2.—Showing a flat lumbar spine with deformity thrown into the dorsal region above the kyphosis.

Plate No. 3.—Showing the straight dorsal spine with the deformity thrown into the lumbar region below the kyphosis.

We see in this series that most of the cases have been deformed by flexion of one portion of the spine on the other, so the idea of treatment has been to hold one fragment in the correct position and make the other fragments straighten out in the reverse steps that it took in producing the deformity.

We fix the lumbar spine, that is our lower fragment (which includes the spine from the site of the fracture down to the feet), by fastening the feet to the bottom of the frame. The lower fragment is held in a horizontal position, and by elevating this lower fragment, the upper fragment drops backward and downward. We thus get extension and counter extension.

We do this by means of a new frame which is hung on the side bar of the bed. The frame consists of a corrugated metal top in two parts,

PLATE NO. 24. -38. Mr. P. B. Aged 35 years. Coal Miner. Fall of slate; crush of 12th Dorsal. Case seen immediately. Side view taken one year after return to work shows an anterior bone bridge connecting the 11th Dorsal and 1st Lumbar. This is an ideal result. This man, a coal miner, was back to work in 6 months, and has worked every day since returning to work that the mine has been worked.

which rests on top of the springs. This top is elevated by oblique arms and controlled by a screw situated at the end of the bed. As the screw is turned, the base is shortened, which also shortens the top, raising the frame. The range of the frame is eleven inches.

The principle of the treatment differs from the treatment on the Bradford frame in that we hold the lumbar spine straight, relaxing the flexors of the pelvis and do not get a lordosis when we hyperextend the upper fragment, but unfold the deformity.

Plate No. 4.—Shows an end view of frame with top of frame on springs, in which position it can be used as a fracture board.

Plate No. 5.—Shows the frame raised about 8 inches from the bed.

Plate No. 6.—Shows a patient under treatment. Notice the feet fixed to foot of frame with the lower fragment level, and the upper fragment hyper-extended. Also notice the position of the chest, the wide costal angle and the digestive organs up in proper position.

After the patient has been corrected as much as it is deemed necessary, then our problem is to hold the spine until healing has taken place, not only of the bone, but also of the soft structures. The ordinary type of

PLATE No. 25.—7. Mr. H. S. Aged 38 years. Coal Miner. Caught by guy rope and thrown into a pit. Deep brush burn of left shoulder. Was in bed for two weeks for a brush burn Nothing done for back. Fracture crush of 1st Lumbar and slight crush of 2nd Lumbar. Side view, showing entire regeneration of bone with anterior bone bridge; also an Albee bone graft in position, and a fracture of the graft which was sustained about a year afterwards in lifting a lump of coal; since graft was fractured, back has been much more movable.

cast with window cut out in front, or with towel put in for room for digestive purposes, did not work out in our cases. The patient deformed in the cast, so my associate, Dr. W. O. Markell, studying Plates Nos. 1, 2, and 3, whereby he could throw the deformity from the lumbar to the dorsal region and vice versa, worked out a new cast.

The patient is put on a horizontal frame shown in picture, No. 7, and the dorsal deformity is corrected by putting the upper fragment in a horizontal plane, thus throwing the deformity into the lumbar region, producing a lordosis. A pad of very thick, solid saddler's felt is sewed to the stockinette with its base at the most prominent spinous process, and an upright of the frame presses against the middle of this pad. Then the cast is applied, and is cut out in the back, the upper portion of the window being at the base of the pad. With this cast, he has three points of support, one in the back at the kyphosis, and two in front, high and low.

PLATE No. 26. 53. Miss I. C. Aged 18. Was swinging on a grape vine swing; fell ten feet; lit on feet, then doubled up and fainted. Severe pain in back; bed one week. Was unable to straighten spine for two weeks and then pain ceased, but she noticed a protrusion of her spine. Back hurting and pain increasing. Crush 1st Lumbar caused by 12th Dorsal. Plate shows healing between the vertebrae with a bone growing from the crushed vertebra upwards to the vertebra above. Example of internal healing.

In the erect position, the force of gravity, the abdominal expansion occurring during respiration and digestion—all tend to push the movable lumbar spine backwards. In other words, the more or less fixed dorsal segment is held straight and the movable lumbar spine is pushed back into a straight line. From time to time, a new pad is inserted under the old one as correction takes place.

Dr. Markell has a cast by which he not only prevents deformity, but can correct deformity; Plate 8 shows three views of the cast.

In older cases, the same procedure is carried out.

What do we accomplish by treatment?

In the early cases, we correct deformity and hold the patient in a correct position until healing has taken place, and this healing consists not only in repair and deposition of lime salts and the formation of bridges of bone, anteriorly, laterally, and internally, *but* in repair and shortening of the posterior group of muscles and ligaments, the anterior group of muscles and ligaments, and the lateral group of muscles and ligaments.

Plate No. 27.—69. Mr. W. M. Aged 38. Coal Miner. Fall of slate; paralysis of both legs, bowels and bladder. Paralysis of bowels and bladder cleared up in eight months' time. Paralysis of legs—muscle power returning now, an equinus deformity with the anterior flexors of the feet weak but all present. He had a crush between the 1st and 2nd and 3rd and 4th Lumbar, the 4th Lumbar being crushed wedge shaped. This view shows lateral healing and very dense bone bridges between 1st and 2nd and 3rd and 4th Lumbar vertebrae on the right side.

In the late cases, a great many cases are first seen with massive bone bridges, anteriorly and laterally (see Cases 27—60—67), where the patients complain of weak and painful back, etc., so that we see that there is something to the problem besides bony fixation. This something, we believe, is fixation in the proper position or posture. In correcting the older cases, the only discomfort is due to the stretching of the abdominal muscles; after they are stretched, there is no complaint.

We aim to accomplish (1) correction of deformity by stretching the anterior muscles and ligaments; (2) getting the patient up in a cast that will hold him while allowing enough function to promote hardening of the bony structures and toning up the soft tissues, and at the same time, permitting the posterior group of muscles and ligaments to undergo compensatory shortening.

In the early cases, without cord involvement, this process takes about six months. I have coal miners back at work in six months' time. (See case 38). Plate No. 24.

PLATE NO. 28. —30., Mr. J. L. Aged 45 years. Coal Miner. Fall of slate; patient complained of no back symptoms whatever. C. C. being injury to left knee. Dislocation of semi-lunar cartilage. Diagnosis of back condition made from history and by physical findings. First set of pictures negative; sent back for 2nd set; was found. Has bone bridge on left side connecting 1st and 2nd Lumbar bodies. Crush bottom of 1st and top of 2nd Lumbar.

In the late cases, six to nine months are required in the younger individuals, and nine to twelve months in the older individuals.

We do not think it is necessary to use any form of internal splinting, because (1st) We have seen in our studies that bony fixation is present in a great many cases in the location where it can do the most good and that patients still are not cured.

(2nd) Bony fixation in the spinous processes prevents motion beyond that necessary for healing and to an extent amounting to more or less disability afterwards.

(3rd) Bone grafting is unnecessary from the time-saving viewpoint because the cases in which we have put bone transplants had to be held as long as the ones that we did not graft. We have placed transplants after Albee's method in five cases and fused one case after the method of Hibbs.

(4th) All operations on the spinous processes interfere with the soft structures and give additional shock to a patient that has already suffered great shock.

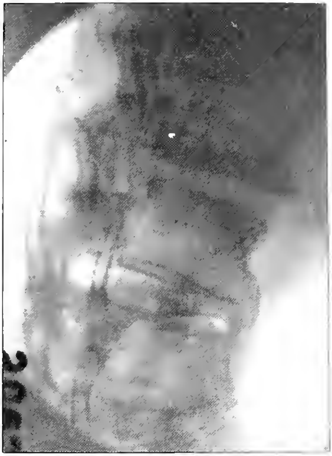

Plate No. 29.—60. Mr. J. S. Aged 39. Miner. Fall of slate; treated in hospital for fractured ribs. Went back to work, but could not work on account of shortness of breath. Had marked angular deformity. Was a crease in his abdomen of overlapping skin 1 inch deep. A marked crushing of 1st Lumbar with strong anterior bone bridge between 12th Dorsal and 2nd Lumbar. This case illustrates that nature has healed the fracture by strong bone bridge, but that the other problem of treatment, the correction of deformity and maintenance of correction, has been disregarded.

Early Treatment of Fractured Spines.—First:—Morphine should be given in fairly large doses for 3 or 4 days to combat delayed shock. Second:—Patient's back should be immediately immobilized to prevent further wounding of soft parts and shock in the transportation to hospital.

Diagnosis:—The following points should aid in diagnosis.

First:—The history of an acute flexion of the spine, as a heavy object forcing the head and shoulders forward, sometimes so that the head approaches the legs, will fracture the spine in nine cases out of ten.

Second:—Prominent spinous processes or angular deformity.

Third:—Localized tender spinous processes.

Fourth:—Limitation of motion.

Fifth:—X-ray; both antero-posterior and lateral views must be taken.

One should always see the plates himself as the plates taken may just miss the site of fracture and be reported back negative.

Sixth:—Sixty per cent. of fractures of the spine are in the lower segment of spine from tenth dorsal down.

CONCLUSIONS.

First:—Many fracture-crushes of the spine, without cord involvement, are unrecognized. A great many physicians think that if a man can walk he has not fractured his spine, and treat him for sprains and contusions of the soft parts.

Second:—The majority of fracture-crushes of the spine receive no adequate treatment. They are allowed up after periods of from one to eight weeks in bed without any support and gradually break down and deform. It is highly essential, no matter how long patient has been in bed, that he have adequate support in order to restore, partially at least, the normal function of the spine, while at the same time preventing the occurrence of deformity until the return of full function is permissible.

Third:—We have found that the spinous processes of the fractured vertebrae will be tender until the healing of the vertebra has taken place and all strain has been taken from it.

Fourth:—It is very easy to fracture a vertebra if weight is applied to the top of a slightly flexed spine.

Fifth:—All cases of fractured spine should be corrected and put in the best position and then held in that position until nature has repaired it. This should be at least six months.

Sixth:—It is unnecessary to do any operation on the spine for internal fixation.

Seventh:—Every case of suspected fracture of the spine should have a thorough x-ray examination, and that means plates taken antero-posteriorly and laterally.

DISCUSSION OF PAPERS OF DRS. AYER, MIXTER AND WALLACE.

Dr. Walter Dandy, Baltimore: We must all be greatly impressed with this beautiful conception of Dr. Ayer; also with the brilliant results which it has brought about. The method, while simple, is not a fool-proof procedure. One cannot help but think of the danger of inserting the needle into the cisterna magna. I have long wanted to use this method. In fact, I have been in communication with Dr. Ayer for some time for some possible value of it in brain surgery. It takes a good deal of nerve to insert a needle into that region, but we have seen from Dr. Ayer's work that it can be done in competent hands without danger. It should not be used by one not skilled in its use. This probably is only the beginning of a large field which will be developed by its use. He has brought out the value in intraspinous growths, and of course with difference of pressure above and below there can be no doubt as to whether you have or have not an intraspinous subarachnoid block. There are other conditions in which we get an intraspinous block. I have been greatly impressed with it in hydrocephalus; inflammatory processes that involve the meninges of the brain also affect the meninges of the cord, and one can get a block in the intracranial subarachnoid space or ventricles and have a second block in the arachnoid of the spinal canal. It would be of tremendous assistance if one could use a cisternal puncture in cases of brain tumor. I recently had a tumor in the spinal canal just below the cranial canal, a case which I felt sure was a brain tumor. There was choked disk, headache, vomiting, etc. The ventricles were of normal size. I explored and found nothing. The case finally came to autopsy. We found a tumor which blocked the spinal canal just below the foramen magnum. By a cisternal puncture alone could we have made a diagnosis on an intraspinal rather than an intracranial tumor.

There is one thing I should like to ask Dr. Ayer. I am wondering whether he can *localize* a growth; after making a diagnosis of an intraspinous growth by subarachnoid block, can he also make an accurate localization? If he can do that, this method would be of paramount importance. I think this is one of the outstanding contributions of many years. It has impressed me tremendously.

Dr. Mixter's paper also interested me very much from a neurologic standpoint. I think we must all conclude pretty much as he has done. We are unfortunately dealing with a lesion in which our diagnosis is far behind our operative procedures. I presume in less than ten per cent. of the cases in which a laminectomy is done is the patient benefited, but we have no way of eliminating those in which the operation cannot be of help. We must strive to make a better differentiation between complete severings of the cord and physiologic block, or those cases in which there is complete destruction of the cord and those in which there is only temporary block due to edema or pressure. In this connection I wonder if this procedure of Dr. Ayer might not be of value to us. I feel very much as Dr. Mixter does, that all cases of complete block of function, those in which there is a complete paraplegia, should be explored very early—the earlier the better. I also feel, as we all must, that there is a period, whether it is 24 hours or whether it is a week—certainly it is no longer than a week—in which good can be accomplished in a certain percentage of the cases, and after which nothing can be done. After ten days or two weeks I do not believe anything can be done in injuries to the spine except in the nerve roots of the cauda equina. I feel pretty much against any refinements of laminectomies. I feel the one big thing is to get a thorough exposure of that spinal cord and to remove all

possible causes of injury, either now or in the future. I feel definitely against a hemilaminectomy or any of the partial laminectomies. Moreover, certainly in a considerable percentage of these cases, there is very marked dislocation of the vertebrae, producing constriction of the spinal canal, so that the spinal cord is under direct compression of the laminae of these vertebrae. That being true, the laminae play a pretty important part in the continuation of this pressure. I feel it more important to remove these laminae which are producing, definitely in many cases, constriction of the spinal canal, and thereby injury to the spinal cord. I think it is very much better to be safe in the all-important matter of clearing up the spinal cord from any possible injury from the spinous processes. The important thing, I think, is, as Dr. Mixter has brought out, to get your cases early and make an early diagnosis, and then make a very complete and thorough treatment. We must hope that it will be possible to make a diagnosis beforehand, between lesions which can be helped by operation and those which cannot. It is rather discouraging to do so many operative procedures on a more or less empirical basis, and that is certainly the condition as it exists today.

There is also a group of cases which Dr. Mixter has brought out and which is well brought out in the work of Allen. These are cases in which the spinal cord is punctured. We have all seen cases in which the spinal cord is perfectly intact, but in which the interior is macerated. Later the spinal cord becomes thinned and ruptures to let that macerated, necrotic material escape into the spinal canal. In a week or ten days after the trauma this necrotic material may often be seen floating in the cerebrospinal fluid. Doubtless it would be a good thing to do what nature herself must later do: to nick the spinal cord into this necrotic centre, as Allen advises. This form of treatment must await the results of many observers. I think we can all agree that the important thing is to get the patient in the first 24 hours, and at present information can be gained only by exploring all doubtful cases.

I am not prepared to make a discussion of Dr. Wallace's paper from a pathologic standpoint. One is impressed by the results that Dr. Wallace brought out. The fact that impressed me was that these cases came so late, and that there was almost an inverse ratio between the latent period in which the diagnosis was made and the time in which treatment was necessary. The time necessary to produce results is double in the later stages. One is very much impressed with the rationale of the method. It is determining accurately the cause of this condition and the institution of rational methods directed toward correction of the cause.

Dr. C. L. Starr, Toronto, Canada: These three papers have been of tremendous interest to me, and I am quite sure it is a great satisfaction to all of us to hear of the work that has been done by these gentlemen who have presented these papers. I think this work will go a long way toward helping us in deciding what should be done in this type of case. I must confess that I am rather a pessimist in the operative procedure in these cases. The proposition of Dr. Ayer has interested me immensely. I think if it were possible for Dr. Ayer to tell us that in the hands of Tom, Dick and Harry it could be made safe it would add definitely to our armamentarium. In a large series of cases of spinal injury, spinal disease, spinal growths, we have, since we have known of Dr. Ayer's work, been tempted to try his methods, but we have not had the courage to do it on living patients, though some of us have tried it in the Anatomic Department. We have contented ourselves so far with spinal puncture and studying the character of the fluid. As he has so well pointed out, the type of fluid is only partially helpful. The find-

ing of the yellow-colored fluid is not very helpful, because it means that the condition has gone beyond the possibility of much, if any, relief being expected. The study of the pressure, however, is valuable. We have unfortunately not been using a water manometer, but a mercury manometer, which is more difficult to handle. We have found that the pressure is very frequently high. The startling point was that it was so easy to lower the pressure. A small amount of fluid withdrawn will drop the pressure almost to nothing. This impressed me with the fact that you have inhibition to cerebrospinal flow. Where this block is, it is hard to determine. It might be in the Sylvian aqueduct, or it might be in the spinal canal, but that does not help very much toward localization. If we have some other localizing method it might help us to that extent. I am only voicing the sentiments of all my own colleagues who have followed the work of Dr. Ayer, in congratulating him on the work thus far accomplished, and in hoping that he may so far advance it that it may be made safe in the hands of our house staff.

I was also interested in the presentation of Dr. Mixter, and I think his presentation and the presentation of Dr. Wallace, if I interpreted them rightly, show that they are rather inclined, with certain exceptions, to operate on most of the cases in the earlier stages. I am not convinced that it is possible to demonstrate in any case whether you have a complete section of the cord or, what in my mind is equally unsatisfactory, a crushing injury of the cord. In both cases the symptoms of a complete section—that is, a physiologic block—are present, with so little hope of recovery that the patient is pretty nearly useless in future life. The other cases illustrated, of involvement of the cord, which unquestionably get well without surgical interference, are to a very large extent of a different type. Then he has a smaller series with improved chances of recovery by fixation. I cannot agree with him as to the method of fixation which he suggests. Wiring the spinous processes together is not a good type of fixation. Neither do I think that a spinal graft or any kind of a graft is a good means of fixation. It seems to me the problem is the same as in any other fractured bone. Immobilization by plaster bed is as good a method as it is possible to get with the expectation that the fracture will unite and the recovery will be as complete as though operative procedures were introduced. My experience is largely in cases of this character. I looked up 33 cases of laminectomy in cases which have come under my observation in the General Hospital of Toronto, and of these 33 I am quite sure that not one of them was benefited by operative procedures. Dr. Mixter claims four out of 52 improved, but this is a very small percentage which have improved very definitely; and those I am not sure would not have improved if no operation had been performed. In spite of the fact that I listened with a good deal of interest to Dr. Mixter's presentation, I am still inclined to feel that, given a case of fracture which can be fairly definitely or even moderately accurately diagnosed as a complete or even partial lesion, the patient has a better chance of recovery if the spine is properly fixed, and I think Dr. Wallace's method of fixation is probably as good as anything that can be done. If the x-ray shows bone fragments impinging on the cord, this is an indication for operation. We have been using plaster moulds—the "Gypsbett" of the Germans, putting the fracture up in the hyperextended position. I wonder if this does not fulfill the suggestion of Dr. Dandy equally well.

I wonder if we are absolutely certain that the edema, which does play a very large part in pressure of the cord in the early stages, will not subside in a reasonable measure, with the possibility of the rest of the cord getting relief from the localized pressure. I wonder if we are perfectly sure that the

edema will not subside with quite as large percentage of relief as if we removed the laminae. I have not seen any case of edema with pressure of the laminae sufficient to make a mark on the cord, which I think is fair evidence. I must confess that my whole attitude may be one of pessimism, but it has been over a fairly long period of time and with a fairly large number of cases, most of which have come to autopsy. Take, for instance, the case Dr. Dandy spoke of in which there was no loss of continuity visible on exposure of the cord, yet on autopsy you will find the cord is so destroyed that the patient could not recover under any circumstances, operative or non-operative. Those cases, I am fairly persuaded from autopsy material, are the ones in which you will find complete section of the cord. Whether those cases will recover to a greater extent after laminectomy is done, I doubt. We have all seen in our war experience cases with evidences of spinal cord pressure which later recover. I am sure we could get recoveries in civilian life. I am still of an open mind on this subject, and if a procedure were presented which held out a very much larger hope of restoration than we have seen, I for one would advocate it with both hands. On the other hand, I do not think it is right to advocate surgical intervention where there is no likelihood of recovery. For that reason alone it seems to me one might be rather hesitant in accepting it.

The sad commentary on Dr. Wallace's paper is that 50 per cent. of the fractures of the spine were undiagnosed.

Dr. J. M. Spellissy, Philadelphia: Dr. Mixter and Dr. Dandy both mentioned the name of Dr. Alfred Reginald Allen. His work on Lesions of the Spinal Cord was experimental, and upon dogs. He performed laminectomies, and then dropped weights at graduated distances upon the naked cord. He increased the weights and distances until paralysis invariably resulted.

He next operated upon a second group of dogs, using the standardized weight and distance, but, as soon as the cord was contused by the weight, he immediately made a mesial, antero-posterior incision with a special, delicate knife at the site of injury.

Dr. Allen's point was, that the swelling following the contusion of the cord —usually within a dense and unruptured dura—should be immediately relieved. In the second group of dogs, so treated, recovery without paralysis ensued, in contrast to invariable paralysis from the same weight at the same distance in the first group of dogs.

Prior to Dr. Allen's report of his work, with exhibition of the dogs, a patient came under my care with complete paralysis and a fractured spine, from a fall from a height. Dr. Charles K. Mills, the neurologist, saw the patient in consultation and suggested that the incision of the cord take place according to the method which Dr. Allen then was investigating, as the patient had received his injury but a couple of hours before the consultation. Dr. Allen not only was present at this first performance of his incision upon a human cord, but lent his own special knife, and assisted by useful suggestions. It was probably within six hours after the injury that the incision was made. It established, first of all, that it did not harm; secondly, the event was temporary improvement in sensation, and perhaps a little in motion. As the injury was high up and of severe character, the man died at the end of some ten or eleven days.

These facts emphasize that if this procedure is to be of service it must be immediate. The dogs operated upon at once recovered, and when exhibited were able to jump several feet from the floor. On the other hand, the man operated upon at an interval of a few hours, experienced but little relief

from the same procedure, though it must be borne in mind that the insult received was probably much more violent than that experienced by the dogs.

Spinal injuries, low down, have much better prognosis. I have seen a woman, two or three of whose lumbar vertebrae were crushed by her being doubled up in a folding-bed accident. Instead of making use of the appliance reported at this meeting by Dr. Wallace, she was turned prone on a hammock with extension to the feet, and a plaster dressing applied. Uneventful recovery, with no paralysis, and subsequent discarding of her celluloid jacket, followed. Another instance was that of a man with partial paralysis and kyphotic deformity in the lumbo-thoracic vertebrae, from pressure on the head. He was treated with extension, and later a brace. A year after he was found not only to have completely recovered from his paralysis, but to have discarded his brace, and to be lifting 50-pound weights in his work, without distress.

The high spinal injuries usually require immediate laminectomy. The experiences of Drs. Starr and Mixter emphasize that of most operators, that laminectomy does no good in a very high percentage of cases. May this not be because they are not operated upon early enough before compression of the nerve cells within the cord has hopelessly damaged them?

Dr. Willis C. Campbell, Memphis: In 1915 I reported in the *Interstate Journal of Medicine* six cases of fracture of the lumbar spine without compression of the cord. Since that time we have observed a great many more, not only of the lumbar spine, but also in the cervical region. If a man has a very simple fall, a very extensive fracture may occur. In one case a young man walking down the street slipped on a banana peel and sat on the buttocks. He was able to get up, and in ten days' time he had considerable deformity. The x-ray picture showed a very definite compression fracture of the first lumbar vertebra without paralysis. I have had one case in the cervical region in which a young woman had a very slight injury, in some way twisting her neck in turning over in bed, and the x-ray showed a definite dislocation of the cervical vertebrae. I have also seen cases in which the patients were riding in an automobile, and on passing over a bump were thrown to the top of car, landing on the buttocks, producing a fracture of the cervical vertebrae. I think we should observe such injuries very closely.

In the spinal column we are dealing with spongy bone, and fractures in spongy bone are sometimes quite difficult to handle, more so than fractures in dense bone. We have more continuous pain, osteitis may exist over a long period of time, as has been noted by Nathan in fractures of the foot. Here we have the same type of bone as we have in the spine.

Another point that I have observed in these cases, is the confusion with tuberculosis of the spine. I have seen quite a number of very definite fractures of the spine that have been diagnosed as tuberculosis of the spine. In one article in which cases of tuberculosis of the spine were reported, I am sure, in analyzing those cases, that a great number were due to fracture, and not to tuberculosis. The x-ray findings are quite similar, as you know.

As to the treatment of this type of case, the conservative treatment, I believe, should be followed first. You very frequently will have a fixation, but there are quite a number of cases that do not improve by conservative measures. In that type of case we must use internal fixation. It might be true that fixation of any kind does not improve all cases. There are very few operative procedures that will give 100 per cent. results.

Dr. A. H. Freiberg, Cincinnati: I rise to ask Dr. Ayer whether he has observed any change in pressures when there is a marked change in the axis of

the body from the horizontal, when the manometers were in place; in other words, what effect does it have if you raise the axis of the body 45° from the horizontal, while the pressures are being observed?

Dr. John L. Porter, Chicago: Regarding the immobilization treatment of spinal fractures, because of my connection with a number of large industrial and insurance concerns, I see a large number of spinal fractures, usually long after the fracture has occurred. I find that practically all of these cases have had no treatment whatever, and in many cases the symptoms have been so trivial at first that the diagnosis was not made. To illustrate how serious an injury the patient may have without immediate symptoms, I want to cite a case of a young colored boy of 21, who was employed by a packing company. While pushing heavy trucks into an elevator—these trucks are mounted on four wheels—the elevator suddenly went up, and he fell down three stories. They went down to pick him up, thinking he was dead. He had picked himself up. He was referred to the office of the chief surgeon, who insisted on his going home. He did, but reported for work the next day, complaining of a little pain in his back. The chief surgeon brought him to me. That is one of the few cases I have seen immediately after injury. We had an x-ray picture taken, which showed a marked compression fracture of the last dorsal and first lumbar vertebrae. I sent him to the hospital. When I reached the hospital the man had not gone to bed. We succeeded in putting him to bed. The next day he was up walking around the ward, and he said he was not going to give up time when there was nothing wrong with him, and against the advice of all of us he went home, and the last I knew, had gone to work.

The feature that has struck me in all of these cases is that if they are not immobilized, no matter how well they apparently are, they have pain for from six to eighteen months afterwards. I have also learned by experience that no matter how long after the fracture, if they are immobilized by such a method as Dr. Wallace describes, the pain disappears.

Dr. C. E. Thomson, Scranton: Last November I had a crushing fracture of my second lumbar vertebra. That is my only excuse for being before you, regardless of the fact that I have done more than one hundred laminectomies. Lest I should be limited to time, I should like to mention in connection with Dr. Starr's remark and Dr. Wallace's paper that there are only about 50 per cent. of those fractures diagnosed. I have a point in diagnosis that I think is somewhat important. I demonstrated this point to the Boston meeting, but, inasmuch as there may be some persons here who were not at that meeting, I may be excused if I repeat it. A man sustains a fracture or an injury to his spine and has pain particularly marked in the sitting posture. Put him in an arm chair, and let him take the weight off his spine by raising his body from his arms on the arms of the chair, and his pain is relieved; let him sink back into the chair, allowing the weight to come on the spine, and the pain returns. That, I believe, is a very important point in the diagnosis, particularly of crush fractures of the body of the vertebrae. I fell sixteen feet out of an apple tree, rode back to town in an automobile, and went to bed and remained there practically all the time for four weeks. I say practically, because I went to the bathroom and did a few little insignificant surgical operations during the four weeks. I then made myself a plaster jacket, which I wore four months. I believe I am in a better condition than if I had been on a Wallace spring or any other fixation apparatus for six months. This is consistent with what we have learned of fractures during the war,—not to

confine them too long, but let them have some movement. I have some pretty-looking adhesions (bony) between the bodies of the vertebrae. I do not suffer any inconvenience. I wore my plaster cast about three or four months.

I would like to say a word or two about laminectomy.

Dr. Porter: How long after you were hurt before you put on the plaster?

Dr. Thomson: I did not have a plaster jacket on while I was in the recumbent position. About one month after I was hurt I put it on. I would like to make an appeal for a class of patients who by all diagnostic evidence are hopeless. We do not know when a patient is hopeless with a fracture of the spine. I think we get benefit, Dr. Starr, from all laminectomies if for no other purpose than that our patients get better treatment than if they were pushed off to die. If these patients are hospitalized and their bladder drained by external urethrotomy, which, I think, is very important, because so many of them die with infected bladder in the first month if they are not drained, a goodly number of them will recover even though they are considered hopeless cases at first. When we take the precaution and trouble to do a laminectomy, we are especially interested in the patient, and he is not pushed aside to die, which I am here to protest against.

Dr. R. T. Taylor, Baltimore: I have half a dozen slides I would like to show. An interesting case that came under my observation was as follows:

This patient was a little girl, S. M., six and a half years old, who, on November 29th, 1913, was sitting on a log, watching some men cutting down a large tree. The tree fell on her, and she was bent double, and pinioned to the log under her. Upon being released, the child fainted, was cyanosed and could breathe only with difficulty. She was revived, but it was immediately evident that she was paralyzed from the waist down, and on more careful inspection, a knuckle was seen at the first, second, and third lumbar vertebrae, projecting backward beyond the surrounding parts three-quarters of an inch. The child was soon carried to a hospital, where an eminent neurologist, the surgeons and family physician concluded it was inexpedient and dangerous at that time, owing to the extreme shock, to consider operative relief. The x-rays then made, showed fracture of the arches, and such close approximation of the first and third lumbar vertebral bodies that the body of the second vertebra was dislocated to the left, through an arc of nearly ninety degrees of rotation, with fracture of the articular processes and laminae of that region. This produced a marked flattening of the spinal canal, from before backward, with bony constriction of the cord and upper portion of the cauda equina. Careful neurological examination made at that time showed complete motor paralysis and anaesthesia, from the fracture down, with retention followed by incontinence of urine and feces from paralysis of the sphincters. Much trouble was experienced later by a tendency to impaction of the bowels. The child was placed on a Bradford bed frame, and the trunk was steadied by sandbags, and she remained at this hospital until January, the condition remaining unchanged, except that sensation returned to the front of the pelvis, the upper third of the thighs, and the gluteal region. The incontinence was distressingly annoying, and only with great diligence could bed-sores and chafing be prevented. The case was referred to me on April 9th, 1914, when I first saw her, and I had her admitted to the Kernan

Hospital for Crippled Children. On examination there seemed to be at that time some return of power in the psoas and iliacus, the anesthesia was unchanged, but her feet were in talipes equinus, and if the child was put in an erect position, the knees were hyperextended (genu recurvatum) and likely to give way just as we see in complete paraplegia from anterior poliomyelitis.

On May 22nd, 1914, under a rectangular lateral skin flap, laminectomy was done, six months and twenty-five days after the accident. The arches of the first, second, and third lumbar vertebrae were removed after biting away with rongeurs the spinous processes, which were found to be firmly ankylosed and fused together. The dura was much thickened, and no pulsation in the vessels in the lower part of the cord and cauda equina was appreciable until the thickened membranes had been well dissected away, above and below. At birth, the cord extends to the lower margin of the last lumbar vertebra, and in this small child the cauda equina was seen to begin at the middle of the third lumbar vertebra. The wound was covered only by the skin flap, which was closed with a subcuticular silver stitch. For two or three weeks after the operation the region of the skin flap bulged and fluctuated like a large spina bifida, and then flattened out. The kyphosis was removed of course by the operation. Progressively, the power began to return in the legs, aided by thorough daily massage, and later the reflexes, which had been absent, could be elicited. The anesthesia cleared up more slowly, and for at least two and a half months after the operation the soles of the feet, the back of the legs and thighs, and the region of the anus were anaesthetic. Finally by September 1st, 1914, the control of the sphincters was fully restored. On September 7th tenotomies of the Achilles tendons were done to relieve the equinus, and on October 30th the child was discharged cured, wearing stop-joint ankle braces to prevent a recurrence of the contracture of the heel cords.

Of spinal injuries, 60 per cent. are fracture-dislocations, 20 per cent. fracture alone, and 20 per cent. dislocation alone. In my experience, the cervical and dorsal regions are more frequently injured than the lumbar, and the higher the lesion the more serious the case, and the greater the operative risk. Adult males, in middle life, more commonly suffer from these spinal accidents than females or children. Compression fractures in the lumbar region were rather common in my service at Fort McHenry, and recovered with fixation. Authorities differ as to the proper time to operate, but the consensus of opinion favors early operation. With the absence of reflexes, Bowlby, Thorborn and Herter advise against operation, whereas in the present case the reflexes were absent, yet recovery ensued. With the severest spinal cord injuries, viz., puncture, laceration, etc., one finds a few successful cases following immediate operation. Lauenstein advocates waiting six to ten weeks for natural repair aided by head and foot traction, fixation by plaster corsets, and, in selected cases, by manipulative reductions under anaesthesia. Horsley advises operation if immediate extension does not reduce the deformity. In 168 cases analyzed by Burrell, in 1894, 22 per cent. recovered by expectant treatment, and 33 per cent. recovered after operative treatment. Gault, in 270 non-operative cases collected, found the mortality 80 per cent. Thorborn, in 61 operative cases gave a death rate of 50 per cent.

Dr. S. Fosdick Jones, Denver: I have been particularly interested in hearing the papers presented by Dr. Mixter and Dr. Wallace, and I wish to speak of a series of five cases of compression fracture of the spinal column with cord symptoms, which have recently come under my observation. It

has been my experience that frequently compression spinal fractures have been at first mistaken for back sprains, or contusions, or mild types of osteoarthritis. A careful and thorough examination should in every instance be made in case of vertebral injuries, and a skiagraph, taken in both the antero-posterior and lateral views, is essential in determining the precise nature of the injury. I agree with Dr. Wallace that the radiographic interpretation should not only be made by the radiographer, but also by the surgeon in charge of the case.

There are five chief points to be emphasized in the skiagraphic examination of compression fractures, and at least two of these points must be present before a definite diagnosis can be determined:

First, the presence of angulation, which may be either a lateral angular deviation or a posterior angulation.

Second, a lateral deviation of the column at the site of the fracture.

Third, and most important, is the diminished intervertebral spacing between the segments of the column.

Fourth, compression of the entire body of the vertebra or of the anterior portion of the body.

Fifth, the presence of an angular kyphos, seen in the lateral radiographic view.

Diminished intervertebral spacing and the presence of either lateral or posterior angulation must always exist, in my opinion, before one is warranted in making a positive diagnosis of spinal compression fracture.

The first lantern slide taken from an x-ray plate of a typical compression fracture of the ninth dorsal vertebra occurred in a man who fell down a mining shaft, a distance of fifty feet. Upon examination following this injury, there were no spinal cord symptoms present. His only subjective symptom was pain on forward flexion of the column, and pain on pressure over the spinous process of the ninth dorsal vertebra. The skiagraph showed a marked compression of the ninth dorsal vertebra, and diminished intervertebral spacing and a slight posterior angular deformity. Immobilization, very similar to that outlined by Dr. Wallace, was carried on for a period of three months, followed by the wearing of a Taylor brace for eight months.

The second case was that of an ex-soldier, who, while serving in the A. E. F. in France, fell from a moving freight train, sustaining an injury to his back, which was diagnosed at that time as a sprain. After ten days in a hospital, he was returned to duty. Eight months later, after his discharge from the Army, having resumed his duties as a postman, he presented himself for examination, complaining of pain over the mid-dorsal spine, and on lifting heavy weights. The presence of the slight angular kyphos, with a compression fracture of the eighth dorsal vertebra, can be seen in the skiagraph.

The third case was a fracture of the first dorsal vertebra, showing a lateral deviation of the fractured dorsal segment and an anterior bridging of bone between the first and second dorsal vertebrae.

The fourth case occurred in a railroad clerk who had fallen between two cars, and was considered to have sustained a sprain of the back and a sacro-iliac relaxation. The examination clinically and by x-ray showed a compression fracture of the second lumbar vertebra, with marked diminished intervertebral spacing and with no cord symptoms.

The first case: I am indebted to Dr. Hart of Denver for permission to show the skiagraphs of a man, who while in the Army met with a spinal injury, which, at the time, was tentatively diagnosed as a compression fracture of the fifth lumbar segment. The examination by Dr. Hart demonstrated

clearly no evidence of a compression fracture, but showed a distinct bulging of bone between the seventh, eighth and ninth dorsal segments, with an angular kyphosis and a lateral deviation of the dorsal column.

I also want to emphasize a point, that in those cases of compression vertebral fractures, that the development of Kuemmel's disease, described in 1895, the symptoms appear late, following vertebral injuries, as a result of falls, and that the symptoms of fracture of one or more segments of the column may not be manifest for several months or even after one year following the original spinal trauma.

It is most important, therefore, that in every case of severe spinal injury, that a careful physical examination, with a neurological and skiagraphic examination, should be made.

Dr. Roland Hammond, Providence, R. I.: I would like to emphasize the importance of taking a lateral view of the patient as he lies on this bed. Ordinarily the patient is turned on the side, in order to take the lateral view. If you are going to regard these as two fragments, and the reduction of the fracture is accomplished by the frame, as Dr. Wallace has suggested, then the x-ray should be taken as the patient lies in bed. This is not only for the purpose of diagnosis, but to follow the progress of the case.

Dr. J. B. Ayer, Boston (closing his part of the discussion): It is very gratifying to me not to have more opposition to a method which must be considered as potentially dangerous. It is of interest that most of the adverse criticism has come from surgeons, the medical men accepting the procedure more readily.

Dr. Freiberg asked whether we had used the method with different positions of the body. It is impracticable to carry out the procedure with body erect; frequently, however, the patient is in bed, with 10° or 15° elevation of the head, and it is easier for him to remain in that position; in such cases the pressures in the manometers rise to the same height under normal conditions, although the needles are not on a horizontal plane.

In regard to Dr. Dandy's question about localization. Naturally that is the next step for demonstration. Thus far I have a few data that help in localization, but of less value than clinical observation. We have tried, as he has, injections of air into the subarachnoid space, but thus far unsuccessfully. Perhaps this method may be developed. Unfortunately, I know of no substances impervious to x-rays which are safe to introduce into the subarachnoid space.

On Dr. Starr's remarks I shall take a little longer. He wants, as we all do, a fool-proof method which will give us the same results as combined cistern and lumbar puncture. If lumbar puncture alone is performed with an eye to getting all that can be obtained of value in this connection, I believe that we can do without cistern puncture in nine cases out of ten. As Dr. Starr has said, lumbar puncture is usually performed without a manometer, or with a mercury manometer, which is not satisfactory in these cases. Then the fluid is examined for cells, globulin, and Wassermann, whereas a test for total protein is the most significant.

I may summarize the tests obtainable on lumbar puncture alone of greatest significance in suspected spinal subarachnoid block as follows: Careful dynamic tests, using a glass manometer of approximately 2mm. bore, observation of pulse oscillations, which are diminished or lost in block, respiratory oscillations which are diminished in low block but much increased in cervical or upper thoracic block, and, most important of all, the effect of jugular

compression on the height of the manometer column, producing in block no rise, or very slight rise, after a latent period. The amount of fluid obtainable is also of significance; sometimes less than 5 c.c. can be obtained below a block. While the usual tests should, of course, be performed on the fluid in the laboratory, an estimation of the total protein, best quantitated with sulphosalicylic acid as precipitant, is the most significant test, and one which is usually omitted. The color is also of significance, and xanthochromia is frequently missed unless the fluid be observed carefully. In early block or where the spinal cord is only slightly compressed, the above tests may be only doubtfully positive. In such cases greater certainty is obtained from combined puncture.

Dr. W. J. Mixter, Boston (closing his part of the discussion): I think the discussion has brought out the fact that we are still dealing with an unsolved problem. My own feeling is that a number of cases will be benefited by laminectomy, particularly if combined with the laminectomy there is incision of the cord in the early cases, as advocated by Hamill. I believe that selected cases only should be subjected to laminectomy.

Sometimes, for some reason or other, a graft is inadvisable, possibly on account of the bad condition of the patient, and possibly because laminectomy has been performed. There is no question in my mind that where possible to insert one, the graft is the best means of fixation, where fixation is indicated.

I wish to thank the Society for the privilege of presenting this paper.

THE END-RESULT IN FOUR CASES OF SEVERE DESTRUCTIVE INJURY TO THE HIP.*

BY TOM S. MEBANE, MAJOR, M.C., U.S.A.

The end-results of severe destructive injuries of the hip are not only interesting but instructive. Most cases of severe injuries of the hip are followed by ankylosis or a flail joint. The four cases reported below are remarkable in that a useful joint resulted in spite of considerable loss of substance and prolonged infection.

Case 1. Pvt. C. S. (Figures 1, 2, and 3.)

This patient received shrapnel wounds of left hip and hand in action on the Champagne front October 6, 1918. The hand was amputated.

Fig. 1

Fig. 2

*From the Orthopaedic Section, Walter Reed Hospital, Washington, D. C.

Fig. 3

The upper end of the femur and acetabulum were badly shattered and infected. Repeated operations were required, and wound drained until June 29, 1921, when healing occurred.

The patient walks with a cane, and has an excellent range of motion at the hip. The passive range of motion is that of a normal hip. Actively, standing, the patient has 40° flexion, 10° extension, and approximately 15° abduction and adduction. There is no pain referred to the joint. There is good stability. The 3½-inches shortening has been compensated for by raising the shoe.

The patient is greatly pleased with the result, and considers himself much more fortunate than his comrade in the next bed with an ankylosed hip.

Case 2. Pvt. J. S. M. (Figures 4, 5, and 6.)

Patient received a high explosive wound of the right hip in action on the Somme front September 29, 1918. The compound comminuted frac-

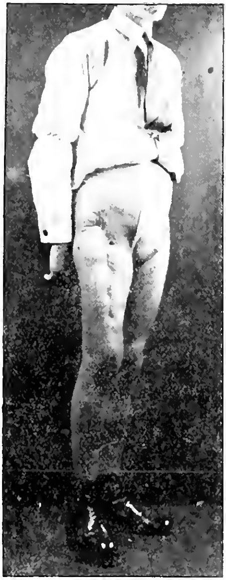

FIG. 4

FIG. 5

ture was badly infected, and the wound drained for two years. Repeated operations were necessary to provide drainage and remove sequestra. Six months after healing had occurred an attempt to remove the head and put the upper end of the shaft in the acetabulum had to be abandoned on account of the excessive bleeding from the old scar tissue. After recovery from operation the patient wore a walking caliper for four months. Caliper was then discarded, and for four months before discharge patient walked with a cane. For the past month patient has been taking daily walks of several miles without ill effects.

Examination at time of discharge: Patient walks well, and sits down without difficulty. Passive range of motion at hip normal except for loss of abduction. Active range of motion standing 30° flexion. The $2\frac{1}{2}$-inches shortening of the leg has been compensated for by elevating shoe. There is complete ankylosis of the knee.

FIG. 6

CASE 3. Pvt. W. H. (Figure 7.)

Patient received a machine gun wound of left hip in action in the Argonne October 4, 1918. The compound comminuted fracture of upper femur and acetabulum was badly infected. Several operations were required before the wound finally healed in August, 1921. On several occasions since small areas of local heat and tenderness have developed and small sequestra have been removed.

Up until recently patient has been walking with aid of crutches. Examination revealed an excellent range of motion with stability and freedom from pain. He is now learning to walk with a cane, and muscle power is rapidly returning. Nearly complete fibrous ankylosis of the knee exists, and the leg is three inches short. The shoe has been raised to compensate for the shortening.

CASE 4. Pvt. A. K. (Figure 8.)

Patient received multiple shrapnel wounds in action in Russia February 4, 1919. The most extensive wound was a compound comminuted fracture, with extensive loss of substance of the upper end of the left

Fig. 7

femur. Severe infection had occurred, and when patient reached Walter Reed Hospital, in addition to a draining wound of the hip he had complete ankylosis of the knee and rigid equinovarus deformity of the foot. The left leg is four inches short.

The patient refused to consider amputation or further operative procedures on the hip. The equinovarus deformity of the foot was corrected and the hip healed without ankylosis. Passively approximately normal range of hip motion existed, and actively, standing, patient had 30° flexion and 10° abduction. The hip was not painful, and stability was good. Patient walks with crutches on a raised shoe. He is very much pleased at still having his leg.

The management of severe injuries of the hip of the nature of the four cases described is a difficult problem. These cases solved their own problem and are satisfied with the result. They can get about without braces. They can sit comfortably. They are free from pain. It had been our intention originally to attempt ankylosis or head of the fibula.

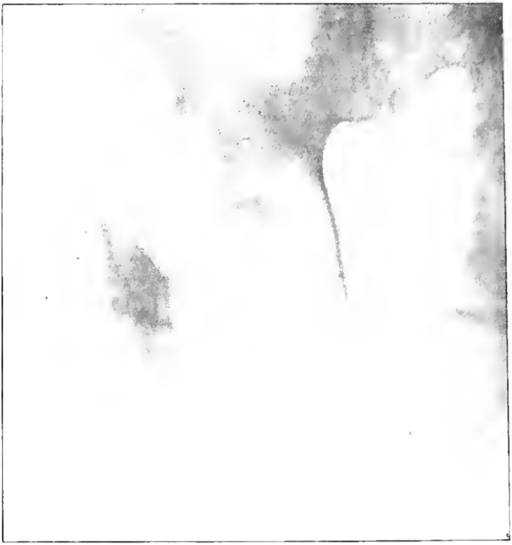

FIG. 8

transplant after sufficient time had elapsed, but, much to our surprise, under the stimulus of use the muscles shortened, and nature manufactured a joint. It is doubtful if any better, if as good, a result could have been obtained by operation. Operation would have been difficult on account of bleeding from the scar tissue. Lighting up of the old infection would probably have occurred. Further shortening of the leg would have been inevitable in all cases.

These cases are instructive in that they demonstrate that considerable loss of substance of the upper end of the femur can be followed by a fairly satisfactory functional result. They also demonstrate that this result can occur in spite of prolonged infection. These results show that extensive resections of the upper end of the femur, in adults, for severely infected fractures, are justified. They would suggest also that it might be justified in severe tubercular or septic disease, in which mortality is high, recovery slow, and tendency to permanent organic damage by amyloid degeneration is great.

THE TREATMENT OF CONGENITAL DISLOCATION OF THE HIP.

BY E. H. BRADFORD, M.D., BOSTON, MASS.

Forty years ago there was no thorough, satisfactory method of treating a congenitally dislocated hip. In contrast, today, the question to be discussed is the percentage of cures offered by the different methods used, in one the choice being between a method involving dissection and one requiring manipulation alone, and another in selecting the most suitable manipulative method. The question is not only as to the ease of possible reduction, but also as to the stability of the reduced head.

Sufficient data are at hand to justify generalization. The present paper is based on the records of a considerable number of operations, both manipulative and by incision. In previous papers statements have been published mentioning different methods employed chiefly at the Boston Children's Hospital. In this paper later conclusions are recorded.

The subject was first called to the attention of the medical profession in Boston by Dr. Buckminster Brown, fifty years ago, who reported a case at the time supposed to be successfully treated by a modification of the Pravaz method, that is, by several years' recumbency with prolonged traction accompanied by massage and daily manipulation. Later Dr. Post attempted manipulative reduction according to the Bigelow method used in traumatic dislocations. Since then all known methods, operative and non-operative, have been employed at the Boston Children's Hospital on a large number of cases, carefully observed and recorded. From this material, generalizations have been possible and various observations from time to time reported, comprising notes on two hundred or more cases treated between 1900 and 1914.

Several papers have been published by the writer reporting the results of operation in these cases examined two years after the end of treatment. In the present paper, the condition of several patients observed ten or fifteen years after the cessation of treatment is presented and is thought to be of interest as indicating the ultimate results. These cases are not selected cases, but are those of a few where accurate information happened to be obtained as to the ultimate functional result.

C. M. Single congenital dislocation of the hip. Age 25 years. Operated upon when five years old by manipulative reduction with mechanical aid. The result 20 years after operation showed a perfect cure with no limitation of motion at the hip joint in any direction. The young lady excelled in all school athletic gymnastic exercises and was noted for excellence in grace and figure.

S. C. Double congenital dislocation of the hip. Under observation for some time at the State Hospital School, Canton. One hip reduced by manipulative reduction with mechanical aid and permanently cured. The right hip was reduced and relapsed and was cut down upon. Motion perfect in the left hip. Some limitation in the right hip. Walks with a slight limp. X-ray shows the development of an abnormal acetabular rim, slightly higher than normal on the hip cut down upon. Patient is engaged in domestic service, and with the exception of the limp in the right hip is free from disability.

G. S. Age 17. Operated upon when two and one-half years old; manipulation. Hip slipped. Later cut down upon and hip reduced by open incision. Motion perfect, except abduction slightly limited. One inch shortening. Hip firm. Trendelenberg test shows even line of buttock. Thickening over trochanter. Health and activity normal. Patient walks without limp.

M. Old congenital dislocation of the hip. Twenty-one years of age. Reduced by manipulation at the age of seven years. Motions free. Admitted to Army and served in France. Walks without limp. X-ray shows hip not in socket, and that the normal anatomical relations at the hip joints have not been restored, but the functional use at the hip was proved by military service.

B. 28 years of age. Double congenital dislocation of the hip. Both hips reduced by manipulation with mechanical aids. Reduction in the right hip not stable; subsequently cut down upon. The patient's present condition presents a cure with perfect motion in the hip reduced by manipulation, but a relapse. In the hip cut down upon, some displacement has resulted, giving a slight limp. No further disability.

E. C. Age 16 years. Both hips reduced by manipulation with mechanical aid at the age of three years. Both hips in place. In the right hip cut down upon, marked stiffness at the hip joint with but a few degrees of motion. Position excellent. There is no distortion of figure.

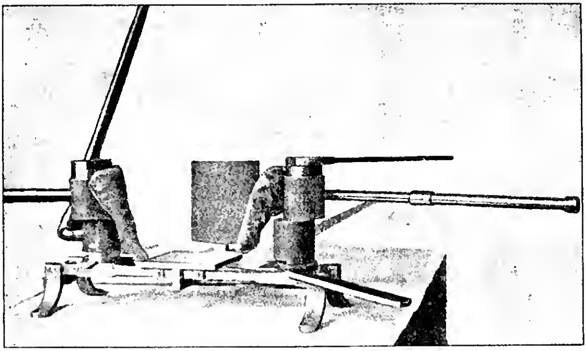

Fig. 1.

LAWYER BARTLETT'S SIMPLE MACHINE.

Designed to make easier the skill of Dr. Lorenz in curing congenital dislocation of the hip, and tried successfully at the Children's Hospital in Boston.

M. F. 25 years of age. Both hips reduced by manipulation with mechanical aid when child was two and one-half years old. Relapse in both hips. Both hips cut down upon. Put in place with careful stitching of the capsule. The after-treatment was interrupted by a severe attack of chicken-pox and later measles, shortly following operation. Neither hip remained in place.

Present condition: Reports after having been struck by an automobile in the right hip. Patient walks with a slight rocking motion. No lordosis or noticeable distortion of figure. No serious injury from the automobile bruise. The patient is able to continue her occupation as a student.

In contrast to this, may be mentioned A. T., age 24, treated when 5 years old for two years by mechanical stretching in bed with traction and traction apparatus followed by gymnastics. Both hips were unreduced and remained in the position of backward dislocation. The patient is short and walks with a slight rocking gait and lordosis and has a somewhat distorted figure. Patient is active and strong; subsequently married and gave birth to a healthy child.

V. M. Age 14. Double congenital dislocation of the hip. Patient operated upon when three and one-half years old. Re-

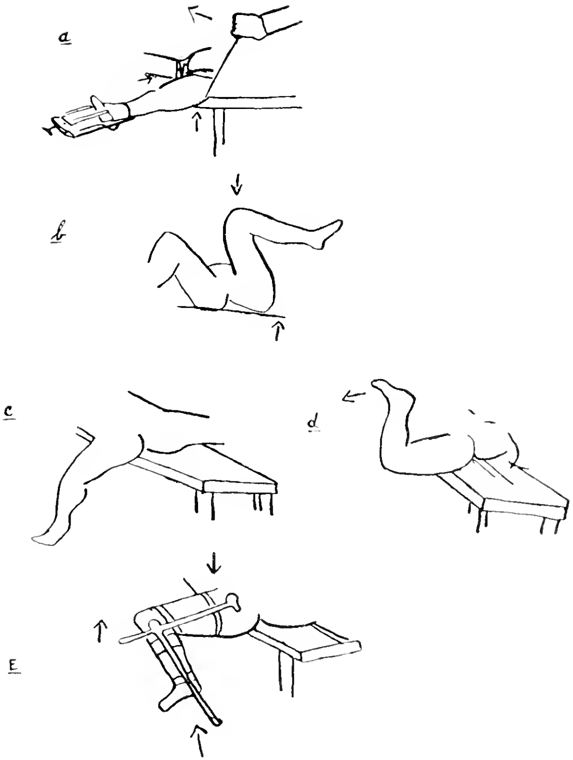

FIG. 2.

a.—Traction and lever applied.
b.—Reduction method by manipulation (patient on back).
c.—
d.—Reduction by manipulation (patient on face).
e.—Manipulating bar to aid reduction (patient on face).

Fig. 3.

N.—22 years old. Milford, Mass. Operated upon for congenital dislocation of the right hip when seven years old by mechanical manipulated reduction. Patient entirely cured. Trendelenberg test normal. Motions free in all directions, except slight limitation in adduction in flexed position. Present condition:—walks perfectly. Has taken a prize for athletic exercises at school.

duced by manipulation with mechanical aid. Both hips in. January 28, 1921: Motion at the hip joints perfect. Limbs of equal length. Trendelenberg test shows both hips in. Ankles and muscles weak. Walks without limp.

These cases are of interest not only because they show the terminal results many years after, through reduction both with or without incisions, but also because it is shown that the cure in successful cases is permanent.

The pathological facts which have been observed indicate that the socket in dislocated hips is retarded in its ossification and development. The ultimate complete cure seems to depend upon the extent of the ossification of the cartilaginous part of the acetabular rim, furnishing a shoulder for the weight supporting the femoral head. In some cases this occurs satisfactorily, in other cases this does not develop normally, as far as can be determined by roentgenograms and functional conditions. Roentgen-ray pictures are known not to be absolutely reliable as

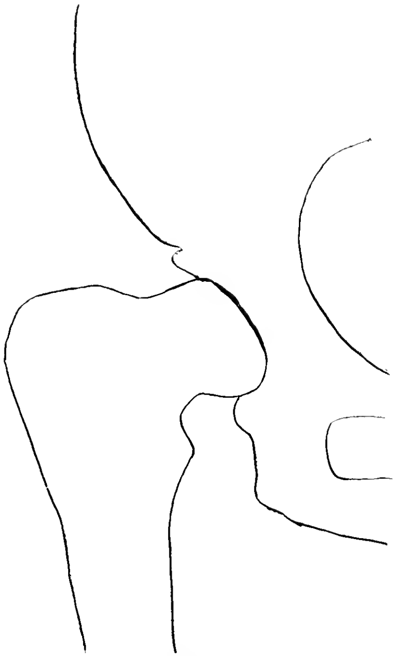

FIG. 4.
N.—Same case. Tracing from an x-ray

evidence, for being shadow pictures, they are only one dimensional and may apparently show the absence of a hollow socket from the shadow of an abnormally prominent front region or of a socket placed anterior to its normal position.

As the x-rays pass through cartilaginous or imperfectly ossified tissue they give no indication of cartilaginous rims which may hold, even if not visible in a shadow picture. This may explain the fact observed in one of the cases in the above series where no socket is shown, though the young man was passed for military service and served in France.—sufficient evidence of a functionally useful hip. From the roentgenograms reported it appears that there is less perfection in the anatomical cure

Fig. 5.

S.—Operated upon when $2\frac{1}{2}$ years old; manipulation. Hip slipped. Later cut down upon and hip reduced by open incision. Motion perfect, except adduction slightly limited. One inch shortening. Hip firm. Trendelenburg test shows even line of buttock. Thickening over trochanter. Health and activity normal. Patient walks without limp.

after reduction by incision than by manipulation. This can, however, be perhaps explained by the fact that these cases were probably those with the greatest anatomical joint deformity. There is apparently from the cases here seen more danger of stiffness after reduction by incision than by manipulation.

In all these cases but two the result was partially or entirely satisfactory. In one, that of double dislocation with reduction by incision in both hips, reduction by incision was effective at an early age. This may be due to the fact that the patient was attacked by measles immediately after the reductions, and the after-treatment was imperfectly carried out. In this case, however, the patient was freed from lordosis and is active, with only a slightly rocking gait, and her condition is much better than that of the other unsatisfactory case of double dislocation upon whom early non-operative treatment was attempted unsuccessfully.

FIG. 6.

C.—Operated upon by cutting when three years old. Patient is now sixteen years old. Hip is strong. Some stiffness in the direction of flexion (one third flexion), one-half inch shortening. Walks without limp. Trendelenburg test normal. Slight adduction, three to five degrees. Patient is well and strong.

The deformity of congenital hip dislocation can now be regarded as definitely curable, but considerable acquired skill is required in reduction and after-treatment. The younger the case, the easier the reduction. Only in infant cases is there any reasonable expectation of cure by splint traction treatment alone, as was noted by the writer in one instance. In a few cases of young infants spontaneous cure has been noted (one observed by the writer), but in patients able to walk, operative manipulation with or without incision is necessary. Permanent cure without any limp or noticeable deformity or defect may be obtained by treatment and this is attainable in a satisfactory number of cases properly managed. Few procedures in surgery are as satisfactory in the result offered to the exercise of trained skill, but in a number of instances imperfect results and relapses follow attempted reduction. These are certain to occur if operative details are not carefully carried out and the after-treatment properly directed.

FIG. 7.

M.—21 years of age. Old congenital hip, reduced by manipulation at the age of seven years. Trendelenburg test normal. Motions free. Admitted to Army and served in France. Walks without limp. X-ray shows hip not in socket.

Failure or partial success in attempts at reduction occur if the contracted and shortened ligaments and the distorted capsule are not sufficiently stretched or torn to permit lifting or twisting the head into its normal place in the socket.

In a large number of cases in young children the reduction of congenitally dislocated hips presents little difficulty to a manipulator of skill and experience, but often even in comparatively young cases much resistance is encountered and anyone who has experience will be glad to avail himself of the help of effective mechanical aid, fixing the pelvis securely and furnishing unlimited correcting power, completely under the controlling hand of the surgeon. The hands of assistants, no matter how well trained, are often not completely co-operative in their assistance.

The resistance varies greatly both in amount and in character according to the changes in structure resulting from the abnormal strains

FIG. 8.

C.—Double dislocation. Left hip reduced by manipulation, normal. Right hip relapsed and was reduced by open incision; new acetabulum was formed. There is shortening and a limited amount of motion. Patient working as a domestic. Has slight limp in right leg.

consequent on the disarrangement of the joint. The tissues involved in these changes are, in order of common occurrence:

Shortened abductor and biceps muscles and accompanying sheaths and fasciae including the ileo-tibial band.

Abnormal and shortened periarticular ligaments toughened by the strain of the body weight, the pelvis being slung to the femoral neck and held close to the upper part of the femur by firm, fibrous bands.

A distorted capsule transformed from the normal pouch to a weight-bearing band stretched from the acetabulum to the head of the femur.

Alterations in the stretched capsule from adhesions to the acetabulum, filling it and presenting an obstacle to reduction.

Alteration in the cartilaginous or bone shape of the acetabulum or femoral head.

Flattening and twist of the femoral neck.

In successful reduction all these conditions need to be considered by the operating surgeon.

The reduction of a congenitally dislocated head is a procedure which can be divided into three steps: the stretching or tearing of resistant tissues; placing the head opposite the entrance into the

FIG. 9.
C.- Photographs taken 10 years after operation.

acetabulum; the replacement of the head into the socket through the distorted and sometimes contracted capsule covering the empty socket. The last step may be aided by a pressure on the trochanter near the neck and by a rotating of the femur as it is abducted. This is easily done in smaller children, but in larger and more resistant cases, precision in manipulation is more difficult.

A most useful apparatus aiding the surgeon in the reduction of congenitally dislocated hips was used at the Children's Hospital, Boston, devised by Mr. Ralph Bartlett of Boston, who, having been led to interest himself in the subject, devoted much time and original thought to the problem of effectively stretching the contracted tissues without injury to the bone structures.

The important principle of this apparatus consisted in furnishing a downward pressure on the trochanter and femoral neck while, at the same time, the limb, also pulled with all requisite force, separating the head from the iliac bone, is forcibly abducted. In this way the contracted tissues, *i.e.*, the shortened adductors, the abnormal ligaments, the faulty attached capsule, are so thoroughly stretched that the femoral head having been pulled down to the level of the acetabulum can be,

Fig. 10.

M.—Patient operated upon April 27, 1912. Double congenital dislocation of the hips. Both hips in. Reduced by manipulation with mechanical aid. Jan. 28, 1921. Both hips in. Muscular weakness. Motion at hip-joints perfect. Limbs of equal length. Trendelenberg test shows both hips in. Ankles and muscles weak. Walks without limp.

with a slight skillful manipulative lift and twist, placed in the socket with the stretched capsule kept tense, thus avoiding the interposition of a fold of the capsule in front of the reduced head.

For a full description of this mechanism, reference is made to a publication presented at a meeting of the Boston Society of Medical Sciences. The effectiveness of this apparatus was amply proved by its use in some fifty successful reductions at the Children's Hospital which have been carefully observed and reported. The apparatus, though effective, needed considerable mechanical skill.

The simplest of mechanical aids in the reduction of congenital hip dislocation, the wooden wedge placed under the neck as a fulcrum in stretching manipulation, lacks precision and is liable to cause paralysis from pressure on the sciatic nerve or fracture of the femur. A better mechanism is needed. It is also desired that, as far as possible, manipulation should be employed at the same time that a downward pull is used on the limb and that the pelvis should be firmly fixed.

An apparatus which was employed satisfactorily in a large number of cases at the Children's Hospital by the writer attempts to meet these requirements. It consists of a strong rod with a traction pull operating by means of a padded ankle strap at the lower end and at the upper, working freely in a socket near and below the perineum and secured to the operating table. As the head is drawn away from the pelvic bone there is little danger of bone injury in the needed forcible abduction manipulation. Counter resistance is furnished by two smooth metal uprights pressing against the perineum. A V-shaped steel bar is slipped on these perineal uprights, shaped so as to reach to and press upon the anterior superior spines, preventing the forward tipping of the pelvis during traction.

If the perineal uprights are fixed in a plate which can be screwed on the edge of a table, a simple portable appliance is furnished to which the socket for the head of the traction rod can be attached and the pelvis can be firmly fixed.

In forcibly abducting the limb it is necessary to exert a downward pressure on the upper part of the trochanter and femoral neck to prevent upward riding of the head, diminishing the stretching of the ileo contractile tissues. This can be done, giving, at the same time, to the manipulating surgeon's hand a desired freedom if he is furnished with a strong steel bar, the lower end of which can be fixed in any of a series of holes made in the steel plate carrying the perineal uprights on which the patient's pelvis rests. The surgeon, moving the upper end of this lever, can exert a stretching pressure in any desired direction, pressing the femoral neck or head down or forward as may be desired while traction and abducting manipulations are employed.

The contracted tissues can be stretched with any desired and readily applied force and the head guided through the capsule kept upon a stretch. This is important in preventing the foldings in the acetabulum of the distorted capsule before the reduced femoral head.

With the aid of this appliance, successful and stable reduction has been effected in patients older than is usually feasible by manual manipulation and with comparatively little bruising of the uncontracted tissue. Several cases of from twelve to fifteen years of age have been successfully treated and one patient of the age of twenty-four was reduced by Dr. Soutter with the aid of this mechanism.

In after-treatment the length of time the corrected limb should be kept in the over-abducted position is a matter of judgment; limited motion without weight-bearing should be permitted to the somewhat

abducted limb as soon as it may be supposed that the ligaments and capsule are able to retain the head in the normal position. Too long fixation weakens the muscles unnecessarily. At the Massachusetts Hospital School the abduction traction splint used there in the ambulatory treatment of hip disease has been satisfactorily used after removal of the fixation plaster. With this it is impossible for the head to slip out under ordinary conditions and the slight amount of protected motion permitted acts as massage on the tissues and promotes an earlier return to normal joint mobility.

After the reduction, which should be complete, with the head firmly placed well in the socket and not merely at the border of the rim, it is important to place the limb in such a position as does not favor relapse by the pull of shortened tissues when the limb is put into use, and permitting, while the parts are recovering from the tissue tear incident to reduction, cicatrization of the loose capsule around the femoral neck and the re-establishment of a retaining cotyloid ligament. The problem of the best position is a somewhat complex one and involves a consideration, not only of the twisted neck and distorted head, but also the periarticular ligaments and adjacent muscular fasciae, not overlooking the iliotibial band.

After a traumatic dislocation the reduced hip tends to stay in position, but the congenitally dislocated hip is liable to slip out until retaining tissues are established.

The best position will necessarily be with the limb strongly abducted, as in this position the reduced head is pressed against the bone structure of the socket, while if adducted, a considerable part lies against the weak cartilaginous rim. As soon as the retaining cartilaginous capsular ring has become sufficiently strong for weight-bearing, the abducted position should be changed and the limb restored to its normal position parallel to the long axis of the body. It is also necessary that the great trochanter should, in the period of cicatrization, be kept in the plane of the cross section of the body and not behind it, for in the latter position the torn ligaments connecting the ilium and the lesser trochanter become too short on healing, and the restoration of the limb to its normal standing position would throw the head out of the socket into the so-called anterior position. Furthermore, the trochanter in the frog position is behind the iliotibial band, and the retaining function of the iliotibial band, pressing on the great trochanter, is unutilized and does not force the head into the socket as it does if the trochanter is in its normal place.

A position of the limb in after-treatment, sometimes advisable, is that of strong flexion with but little abduction. The choice of the position of the limb in after-treatment, the change of position, and the length of time before motion is allowed are matters of judgment and cannot be formulated, as they are dependent on structural conditions varying in individual cases. The one to be preferred in each case is that which will hold most securely the reduced head in the socket until the tissues have shaped themselves to meet the strain of normal function.

It is sometimes difficult to determine with certainty whether a complete reduction has been effected at the time of the operation or whether the head is separated from the bottom of the socket by a fold of crumpled tissue. A reliable test is furnished by the tension of the hamstring tendons. These muscles, in congenitally dislocated hips, are shortened and are made tense with the elongation of the limb which follows the placing of the head in the acetabulum, *i.e.*, in a lower position. The shortened muscles are seen in the flexed position of the knee following placing the head well in the socket and resisting straightening the leg. Another important test is the position of the head if reduced. This should be under the femoral artery, and not to the outside.

X-ray pictures, though of service, are not wholly reliable in determining whether or not a complete reduction is accomplished, for the reason that ossification of the femoral head, always incomplete in young children, is even more so in congenitally dislocated femoral heads and acetabula, and consequently the exact relation between the largely cartilaginous head and socket is not accurately shown. This is also true as to the exact condition of the bone structures before reduction, especially as to the shape of the head and the depth or shallowness of the acetabulum. In some instances the acetabulum is situated in front of its normal position, which would give to a shadow picture the record of an absent socket, though in reality it is only misplaced.

The only absolutely satisfactory standard for estimating the results of treatment is the condition in the use of the joint and limb some years after reduction. It can be expected that in practically all usual cases in very young children operated upon before much bone distortion has been established, practically normal joint function will result from careful treatment. In older cases the perfection of the result will depend upon the condition of the bones before reduction and the ability of the tissues to grow to the normal type after more normal use.

In almost all cases if the reduced hip has remained in place after a year of active use it may be considered that the cure is a permanent

one. In a few cases, however, in growing girls relapses have occurred after several years of normal function during the changes in the skeletal growth which occur at the time of puberty, although the reduction was complete as far as could be determined by the evidence of normal function and careful examination several years after reduction. These cases are exceptional and do not affect the general rule that a complete cure is ordinarily to be expected after complete reduction and proper after-treatment.

As no one would be justified in cutting down on an ordinary traumatic dislocation of the hip, so in the usual case of congenital hip dislocation with the present knowledge of manipulative procedures, reduction by means of incision is unsurgical. Formerly, before the nature of the deformity was as well known as it is today, it was thought that no one could be sure of a satisfactory reduction unless the obstructing tissues were thoroughly removed by dissection and incision. It was in this opinion that some fifty cases were reduced by open incision at the Boston Children's Hospital in the series under review. The procedure is a most satisfactory one to the surgeon, as there is no uncertainty of the completeness of the reduction, and the exact condition is not a matter of conjecture, but of visual certainty, but the distorted capsule and abnormal ligaments are so deeply placed that they cannot be reached without a relatively deep dissection involving more trauma to tissue than is to be expected in a skillful manipulative reduction. The resulting cicatrization may, therefore, interfere with a perfect functional result. Furthermore, the procedure of reduction by incision is a more severe ordeal for the patient and involves more risk if the surgeon has not gained considerable experience in the treatment of the deformity. Failure in manipulative reduction entails only bruised tissues, while deep incisions involve considerable dissection and a comparatively large wound. For this reason, the procedure by incision should be reserved for exceptional cases when a relaxed or distorted capsule demands the aid of the knife.

Osteotomy of the upper end of the femur before or after reduction, advocated to overcome the twist of the femoral neck, will be found unnecessary. If the reduction is complete and stable, the muscles adjust themselves to the new relations, and locomotion and joint function become normal despite the femoral twist, a defect which is not uncommon in undislocated hips and which entails only a somewhat posterior position of the great trochanter without interfering with the movement of the joint. Furthermore, as bone normally used tends to grow to type, the twist tends to correct itself after reduction.

Although from the cases mentioned in this paper an impression might seem justified that the results following manipulative reduction were superior to those following reduction through incision, such an opinion cannot be considered as entirely warranted. More care is necessarily required where dissection is needed and the procedure will be reserved for the more difficult cases. After-treatment will also need to be carefully judged to prevent joint stiffness. There is no reason, however, to suppose that with scrupulous aseptic attention to operative details, and the early resumption of protected locomotion, excellent results may not be the rule after reduction by incision as by manipulation.

The existence of bone distortions in the head, neck and socket diminishes the chance of perfect cures, but not of substantial benefit. Flattened and twisted necks may well be left to the vis medicatrix of natural growth in young and even in adolescent cases, but in the rare instances of badly distorted heads unsuited to fit in any acetabulum, reshaping knife or chisel is perhaps necessary, but probably in a shallow socket better functional results are obtained by carefully securing the capsule around than by gouging out a deeper acetabulum. After all such cutting operations, early movement of the limb is indicated with locomotion protected by crutch or splint.

Whether in double dislocations both should be operated upon at the same time is a question of judgment. In the more resistant cases, the reduction should be done singly.

No matter what method any surgeon recommends, it is true that as there is a variety in the resistance met in deformity of congenital hip dislocation, a surgeon should be skilled in several methods of reduction if he wishes to employ the most suitable method in each case, correcting the most resistant obstacle effect as it presents itself. The shortened hamstrings are more readily stretched after the hip is reduced, while the adductors can be stretched during manipulation, but the pelvis should be well fixed and the trochanter pressed down as the thigh is strongly adducted. A contracted and distorted capsule needs not only to be strongly pulled upon, but also to be gradually dilated at the same time by the pressure of the head forced through what remains of the normal capsular sac narrowed at the acetabular rim. Faulty bone conditions of the head, neck, and acetabulum are to be considered in the twist and pressure of the final replacing manœuvre and also in the position after reduction best suited for establishing normal joint function.

Perhaps the most important condition to be considered in reducing a congenitally dislocated hip is the abnormally strong and abnormally

developed ligamentous bands passing from the pelvis to the femoral neck and especially to the lesser trochanter and closely connected with the distorted capsule. It is this distorted tissue which sustains the patient's weight, normally borne by the femoral head in the socket. These ligaments vary considerably in strength and elasticity and for this reason different procedures are serviceable in different cases suited to different degrees and varieties of resistance. These variations can be recognized by the surgeon in manipulating the limb and can be demonstrated on examining pathological specimens of the deformity of congenital dislocation of the hip. This variation in the attachments of the abnormal ligaments, as well as the condition of the distorted capsule is known to any surgeon who has had an extensive experience in the reduction of dislocated hip with the aid of open incision and dissection. The extent of the development of the cartilaginous portion of the acetabular rim and of the cotyloid ligament varies considerably and needs to be reckoned with. This condition can in a measure be determined in the manipulations of the surgeon.

It is apparent that as in the reduction of a traumatically dislocated hip the Y ligament is the important anatomical factor, the key fact in the reduction, so the abnormal ligaments, which may be regarded as distorted changes in the Y ligament, must be borne in mind in the reduction of congenital hip dislocation. Reductions may be affected without recognizing the special importance of these resistant tissues, but in thorough surgical procedure this obstacle is to be carefully overcome if relapse is to be prevented and the best results secured. These ligaments check the ascent and descent of the femur beyond certain limits, but allow considerable motion in flexion, extension, and even ab- and adduction, the dislocated head moving out of, and not in, the socket. This laxity is enough to cause the slipping which gives the characteristic gait but prevents pulling the dislocated head down to the level of the acetabulum. An attempt to overcome the obstructing tissue by dissection is made difficult by the irregular distribution of the ligamentous bands and their insertion on and in the neighborhood of the lesser trochanter, requiring a deep as well as somewhat extensive dissection of innocuous tissues, with resulting stiffening cicatrices.

In the earlier attempts to treat the deformity empirical efforts were made to stretch the tissues, but they lacked precision. Post was correct in assuming that, as in traumatic dislocation, theoretically the reducing manœuvre should be made with the resistant tissue relaxed. These tissues, however, need to be made normal by stretching in congenitally dislocated hips after reduction; otherwise relapse will occur. Pravaz,

Little, and Buckminster Brown, as well as Hoffa (in his earlier attempt at reduction by incision) were not informed through the then lack of pathological knowledge of the existence, in most cases of the deformity, of a competent, but closed, acetabulum. Methods of stretching or tearing the contracted tissues, to be combined by a pulling force with abduction, can be made effective. As has been mentioned, the efficiency of a pulling force can be increased by mechanical aids, especially if the pelvis is properly held.

As the head of the femur in a dislocated hip, if not checked by the capsule, can move in a considerable excursion around the socket, and as the socket rim is less an obstruction at its posterior border than at the upper border, reduction would be more easily effected if the thigh were strongly flexed. The lesser trochanter being held by the shortened ligaments as the fixed point above the acetabulum, by strongly flexing the thigh the free femoral head would be brought opposite the lower and posterior part of the acetabulum and could be manipulated into the socket without opposing the resistance of the shortened tissues. The obstructions which would have to be overcome in placing the head into the socket would be those of the capsular tissues. The remaining contractions in this procedure will be corrected after reduction. This manipulative procedure has certain advantages, but is probably less serviceable in a closely covered socket or a badly contracted capsule.

In reducing a congenitally dislocated hip it is important that the surgeon should not only bear in mind the position of the unreduced head but should be able to exert pressure upon the head or femoral neck whenever such reducing pressure may be needed. It is, therefore, often convenient in less resistant cases to attempt reduction by placing the patient on the face with the limb to be operated upon hanging free, the patient lying at the edge of the table. Pressing the pelvis down on the table helps to steady the pelvis while the surgeon manipulates the limb with one hand and can press with the other hand upon the femoral head. If this procedure is attempted in any but small cases difficulty will be met in easily manipulating the affected limb, giving the requisite twisting and abducting as well as flexing movement when needed. A simple and convenient aid can be furnished by bandaging the limb to a steel bar slightly longer than the thigh, with the leg flexed at the knee to another bar at right angles to the first and socketed to it. The projecting ends of the bars serve as handles aiding manipulation. There is no danger of fracturing the shaft of the femur or of injuring the ligaments of the knee, no matter how much force may be exerted in manipulation, and the surgeon has the trochanter under his hand as

well as the unreduced head under observation by palpation at each step of the manipulation. Pressure can be exerted as desired on the femoral head and on the trochanter directly, while the surgeon is exerting a strong lever-acting force on the rest of the limb.

Preliminary capsule and muscle stretching can be given to the pendent limb by connecting an ankle strap to a stretching rod with a stretching attachment and furnished with perineal counter-resistance.

Reduction of congenitally dislocated hips by the aid of incision, though not advisable in ordinary cases, is a method the surgeon should be prepared to employ in exceptional and difficult cases, and the procedure can be made a most satisfactory one, requiring careful attention to anatomical details and aseptic precautions as well as well-planned after-treatment. Familiarity with the various distorted changes existing in the deformity is needed by the surgeon, who should be ready to meet unanticipated anatomical conditions.

For details of operative technique reference is made to special articles on the subject.

If, as seems probable, the congenitally dislocated hip is the result of a prenatal laxity at the cartilaginous part of the hip joint from incomplete development of the tissues, an absolute cure can be expected after stable reduction and with normal use during the period of rapid growth, provided the reduction is effected before marked changes have taken place from the abnormal use of the imperfect joint, and provided the reduced head is kept in place until the retaining structures have been sufficiently developed in strength to perform the function of holding the head in place. Such an opinion seems absolutely justified by well-recorded results in many clinics.

An absolute cure is to be aimed for in all young cases, and even though normal function is not always gained, marked improvement is to be expected. Operative treatment, to be beneficial, demands, owing to the complex nature of the deformity, unusual care not only in the different steps of the operative procedures, but also in the after-treatment, the exercise as well of sound judgment in delaying, as well as encouraging, the use of the affected limb.

The deformity should be corrected as early as is feasible before active locomotion of the child occurs.

Any treatment before this should consist in the application of a traction abduction splint and in a few cases this may be corrective, but only in the simplest cases.

Reduction by forcible manipulation under an anesthetic is the method of choice in the large majority of cases. This, in resistant and older cases, should be aided by such efficient mechanical aids as fix the pelvis and give the surgeon's hands greater power without hampering the skilled movements of the operator.

Reduction by incision is to be reserved for the cases where manipulative reduction has failed.

The after-treatment is as important as the reduction. The reduced hip should be held in place until strong retaining tissues for the normal position have been established without the development of cicatrical contracted tissues which will tend to throw the head out of the socket when the normal weight-bearing is resumed.

Fuller details are presented in the following earlier articles by the writer. (Congenital Dislocation of the Hip.)

The American Journal of Orthopedic Surgery, August, 1909.

Report of the Staff at the Children's Hospital. Reprinted from the *Boston Medical and Surgical Journal*, Vol. cli, No. 4, pp. 85-92, July 28, 1904.

Twists in Normal and in Congenitally Dislocated Femora, *New York Medical Journal*, December 5, 1903.

Surgery, Gynecology and Obstetrics, August, 1906.

Annals of Gynecology and Pediatry, Boston, November, 1902, Vol. xv.

Zeitschrift f. orthopädische Chirurgie, xxxiv Bd.

The writer would refer especially to two interesting articles in the *Journal of Bone and Joint Surgery* by Dr. Bernstein of Chicago and Dr. Z. B. Adams of Boston.

Conclusions as to the pathology of this deformity have been drawn from the following specimens at the Warren Museum, Harvard Medical School.

9908. *Hip. Congenital Dislocation.* The pelvis and both femora, in fluid.

There is a lack of development of the acetabulum and cotyloid ligament with slight tapering of the head of the femur. These factors rendered possible abnormal mobility of the femur in its socket and consequently an abnormal attitude of the extremities.

From a malformed foetus, 1903. DR. SAMUEL ROBINSON.

10088. *Hip. Congenital Dislocation.* The pelvis and both femora, in fluid.

There is great contraction of the capsule at the neck which shows the difficulty of reduction without incision.

From a child two years old. Both the hips were operated upon by manipulation unsuccessfully. Later the left hip was cut down upon and successfully reduced. Death followed six months later from whooping cough. DR. E. H. BRADFORD.

10088-1. *Hip. Congenital Dislocation.* Half of the pelvis and one femur, in fluid.

It shows the anomalies of the capsule in a case of congenital dislocation.

From a child who was not operated upon. DR. E. H. BRADFORD.

8593. *Hip Joint. Double Congenital Dislocation.* The pelvis and both femora in fluid.

The heads of both bones are dislocated backward and upward, and there has been formed about them a new socket, which is partly fibrous and muscular. On one side an attempt has been made to overcome the deformity by making a new socket for the head. The obstacle to bringing the bone into its new position was the resistance offered by the anterior part of the capsular ligament (Y ligament of Bigelow).

From a child nine years old who died from diphtheria one month after operation. 1894. DR. E. H. BRADFORD.

1418. *Hip. Congenital Dislocation.* The pelvis and both femora, dried.

The necks of both femora are very much reduced in length, standing off from the shaft at a right angle, and end in irregularly rounded knobs, rather than proper heads. The acetabulum is irregular and quite shallow but does not present any evidence of inflammation.

From a middle-aged woman. 1863. DR. D. W. CHEEVER.

6567. *Femur. Congenital Dislocation.* The head and neck of the femur.

The neck is quite short and terminates in an irregular enlargement with small rounded elevations, especially along the edge, but without any proper head.

From a woman 50 years old. 1853. DR. SAMUEL CABOT.

1413. *Hip. Congenital Dislocation.* The os innominatum and femur, dried.

The os innominatum is very thin and light. The cotyloid cavity is irregular in shape. Superiorly, and somewhat posteriorly to its rim is an articulating surface, which was covered with smooth cartilage. The femur is atrophied and the head of the bone has disappeared, and about 2 cm. of the neck remains irregularly rounded at its extremity.

From a woman 60 years old. 1858. DR. R. M. HODGES.

5200. *Hip. Injury.* A portion of the hip bone and femur.

The acetabulum is small, irregular and shallow, and the dorsum of the ilium somewhat hollowed, but without the least appearance of a new socket. About one-third of the femur remains irregularly flattened, and the neck is much shortened.

From a woman 59 years old who received injury at birth. 1840.
DR. HOMANS.

THE USE OF THE INDEX FINGER FOR THE THUMB: SOME INTERESTING POINTS IN HAND SURGERY.

BY JOHN DUNLOP, M.D., LOS ANGELES, CALIF.

My idea in presenting this case to you today is to bring out some of the more important points of hand surgery which illustrate the functions of the hand. Perhaps the better way to illustrate the points I have in mind would be by presenting the history of my case prior to operation and show the illustrations depicting my operative result.

The case is that of a British officer who presented himself to me with the following condition: he had lost the thumb of his right hand; in addition he had a number of fractures in the carpal area, the wrist was stiff or nearly so in the straight position, and the index finger, due to the destruction of the base of the metacarpal, was somewhat shorter than normal, whereby the metacarpophalangeal joint was retracted. The extensor muscle of the index finger was not functioning and the finger was slightly flexed and abducted under the mid finger. The position of this finger had a great deal to do with the lack of functioning of the middle, ring and little fingers at the metacarpophalangeal joint. With the hand in this condition he had used it but little and there was practically no motion except a slight amount in the two inter-phalangeal joints.

The reason for lack of function of the remaining portion of the hand was as follows: 1—loss of thumb; 2—stiff wrist in straight position; 3—retraction of metacarpophlangeal joint of index finger, destroying the normal arch of the metacarpophalangeal joints; 4—abduction of the index finger under mid finger further interfering with motion of the remaining fingers.

The problem, then, as it appeared to me, was to get the index finger out of the way of the other fingers so that function might be restored in them, and in planning this operation it seemed to me that because of the position and uselessness of the index finger, it was advisable either to amputate it, which the patient wanted done, or to preserve it and use it in place of the thumb which he had lost. It seemed to me that this could be easily done by rotating the metacarpal and the remaining portion of the finger after an osteotomy at the point of fracture and plac-

*Read at the meeting of the American Orthopedic Association, held at Washington, D. C., May 1-3, 1922.

No. 1.

Lateral view, showing ability to oppose index finger against thumb, in reconstructed hand.

No. 2.

Showing power of opposition with index finger used as post. Also shows restoration of function of fingers at metacarpal phalangeal joints.

No. 3.

Showing position of finger used as thumb in the passive position, together with the area of abdominal graft between metacarpals.

No. 4.

Showing position of thumb in palmar view.

Nos. 5, 6, and 7.
General views of hand.

ing the finger in the position of the thumb when taking hold of objects. It has been clearly demonstrated that the position of function of the thumb, that is, the position of apposition, varies very little; that is, the angle which the metacarpal makes with its relation to the metacarpal of the index finger, varies only a few degrees at any time. It therefore occurred to me that if I could put the metacarpal of the index finger into a position in relation to the metacarpal of the mid finger, similar to the normal relation of function of the metacarpal of the thumb to the index finger, although we might not get a functioning thumb, we should at least get a post against which the flexion action of the fingers could work in grasping objects.

This operation was performed in three stages, the first consisting of separating on the back of the hand the metacarpal of the index and mid fingers and loosening the bone union between the carpal mass and the stump of the metacarpal of the index finger. It was then possible to rotate the finger without in any way interfering with the nerve or blood supply, other than it had previously been interfered with through the original wound.

It was then found that it would be impossible to cover in the space between the two metacarpal bones by any form of plastic operation on the skin, so a skin and fat graft of the abdominal wall was turned up and the lower end of the graft was sewed to the dorsal edge of the wound as far as possible. The hand was then left in this position for thirteen days, the wound in the meantime being dressed daily and kept clean by the use of boric powder. On the thirteenth day, under full anesthesia, the flap was cut off from its attachment to the abdominal wall and the operation of attaching the graft to the area on the hand completed. The abdominal wall was likewise closed. For a few days the last edge which was sewed from the body looked rather angry and there was considerable oozing of an oily substance, which was unquestionably due to fat necrosis, as the subcutaneous tissue obtained contained a very thick fat area. Finally nearly the whole of this surface sloughed loose but did not at any time separate more than half a centimeter. It was kept perfectly clean and healed practically without infection.

Prior to operation the sensory nerve supply and blood supply to the index finger gave it a distinctly bad color and it was without sensation. The base of the metacarpal, due to the frequent handling and dressings, did not become firmly enough united to the carpal area from which it had been broken loose. I therefore decided to go in with an at-

tempt to get bony union in a good position. This was done with the result that I now show you; bony union is not present but apparently a very firm fibrous union.

The result obtained with the material at hand, I believe, is fair. There are certain features in connection with this case which have interfered with a more perfect result; for instance, the stiff wrist in the straight position, a wrist which functionally cannot be in the strong position of dorsiflexion. This in itself clearly militates against a powerful grip; then again the fact that I was dealing with an index finger without nerve supply and with very poor blood supply and with a stiff carpometacarpal joint, all of which interfere with flexion or extension of index finger used as a thumb.

It would seem to me that such an operation could be applied to one whose hand was practically perfect except for the loss of a thumb in which almost normal function could be restored. For instance, I can conceive of a case where an index finger is split off and put in the abducted position with an osteotomy at the base of the metacarpal of the index and where all of the nerve and blood supply is retained and good function of the wrist is present, with the result that we should get a very useful hand. It has been my hope that such a case would present itself, but to date I have not been fortunate in getting one.

I believe that in hand function, other than cases of paralysis, due to nerve injury, we have three very distinct pathological conditions which interfere with good function: first, loss of the thumb used as most thumbs are, as a post against which the grip is made; second, the retraction of the metacarpophalangeal joint which, when present, in all cases restricts function proportionately with amount of retraction, a condition which I believe is not taken sufficiently into consideration in fractures of the metacarpal; and third, the destruction of the wrist joint motion with the joint in the straight position of strength, being about 30° of dorsiflexion.

STRUCTURAL SCOLIOSIS COMPLICATED BY PARALYSIS OF THE LOWER LIMBS—REPORT OF A CASE.*

BY S. KLEINBERG, M.D., F.A.C.S., NEW YORK.

THE following case is reported because of the extreme rarity of paralysis complicating scoliosis. The patient, a girl 9 years old, was referred to me in June, 1921. Her chief complaint was difficulty in walking. The family history was of no interest and was not pertinent to the patient's condition.

History:—The patient began to walk at the age of 1 year and walked fairly well at a year and a half. She was apparently well until two years before her first visit to me, when it was noticed that the right side of her back was more prominent than the left. She was taken to the Hospital for Ruptured and Crippled, where a diagnosis of curvature of the spine was made and a corrective plaster jacket was advised. At that time the patient walked well. Seven months later she again visited the hospital and was advised to join the gymnasium class for corrective exercises. She attended the gymnasium for a year, taking part in the exercises with the other children in the class, and having apparently no difficulty in locomotion. At the end of this period, that is, about five months before she consulted me, the parents noticed that the deformity was more marked and that her walking was awkward and difficult. She tired easily. The difficulty in walking increased and became suddenly aggravated one week before I first saw her.

Examination showed that the child was in good general condition. She presented a marked right-dorsal rotary lateral kypho-scoliosis. The posterior curvature of the spine was more marked than the lateral. There was an unusually marked compensatory lordosis. There was evident shortening of the child's stature and telescoping of the thorax into the abdomen so that there was a manifest disproportion between the height of the trunk and the length of the limbs. The appearance of the back was as is shown in Figs. 1 and 2. There was a recurvature of both knees with atrophy of the lower limbs. She could stand alone but swayed a great deal and sought support. She could walk alone a little, but her gait was very unsteady. She could not bend her trunk forward to the normal degree because she lost her balance.

*Case presented at a Clinical Conference of the Hospital for Ruptured and Crippled, June 6, 1922.

FIG. 1.—Posterior view of right dorsal structural kypho scoliosis. Very marked posterior curvature of the dorsal spine and marked compensatory lumbar lordosis with evident shortening of the trunk.

During flexion of the spine the posterior curvature became markedly exaggerated. There was moderate spasticity of the lower limbs, and marked weakness of the muscles. The upper limbs were not affected. The knee and ankle jerks were exaggerated. She was unable to rise from the sitting position, and was unable to sit up when recumbent. At no time did she have any pain in either her back or lower limbs,—that is, pain of a spontaneous nature or induced by manipulation.

X-ray examination (Figs. 3 and 4) of the spine showed that the 5th, 6th, 7th, 8th, 10th and 11th dorsal and the 1st and 3rd lumbar vertebrae were abnormal. The 5th and 6th dorsal had incompletely fused posterior arches and the bodies were wedge shaped. The 7th and 8th dorsal had no posterior arches. The 10th and 11th dorsal and the 1st lumbar vertebrae showed lack of fusion of the posterior arches while that of the 10th dorsal was very small. There was an interval of at least a quarter of an inch between the lateral masses of the posterior arch of the first lumbar vertebra. The third lumbar vertebra showed a very poorly or incompletely developed posterior arch. In the lateral view, wedging of the mid-dorsal vertebrae was distinctly visible.

FIG. 2.—Lateral view of same case. Shows disproportion between height of trunk and length of limbs. Also marked lordosis.

This was evidently a case of structural congenital scoliosis due to malformation and abnormal development of many of the dorsal and some of the lumbar vertebrae, with an unusual degree of posterior curvature of the dorsal spine. The paralysis was apparently the result of pressure on the dorsal segment of the cord due to the marked rotation and posterior angulation of the dorsal vertebrae. Repeated neurological examinations did not show any intrinsic lesion of the cerebro-spinal axis. The motor weakness was undoubtedly the result of pressure upon the spinal cord. Laboratory tests of the blood, spinal fluid, and urine were negative.

It was decided that the child should be treated as if she had paraplegia following Pott's disease, and for that purpose she was admitted to the Hospital for Ruptured and Crippled. A few days later the weakness of the limbs increased to complete paralysis and she was unable to stand or walk. She was placed on a convex stretcher frame, which was bent to more than the usual degree in order to reduce the posterior curvature of the spine as rapidly as possible. For a long time there was no improvement and I was very doubtful about the ultimate result. At the end of two months she began to move her toes and feet, although

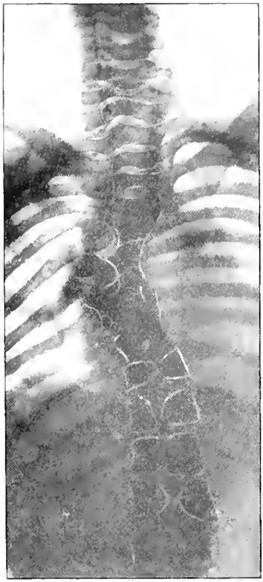

FIG. 3. Antero-posterior Roentgenogram. Outline of vertebrae exaggerated for a clearer view. Note the very extensive malformation of almost all of the dorsal vertebrae.

during the following month there were many days when she could not do so. The treatment was continued and soon the improvement advanced to a well marked degree. At first she moved her toes; then she began moving the ankles, flexing the knees and, to a slight degree, the hips. Then she began using the gluteals. Soon she could elevate the limbs from the frame, and finally she was able to control the limbs while lying in bed, lifting them and moving them about in various directions at will. A plaster of paris Calot jacket was applied, and standing and walking were attempted. After she had worn the jacket a few weeks she was able to walk. Now the deformity is very much reduced and she can stand and walk without difficulty or effort. She is still wearing a plaster jacket which extends over her shoulders, but it is not

Fig. 1.—Lateral Roentgenogram. Showing very marked posterior curvature of dorsal spine.

of the Calot variety. During her entire stay in the hospital her legs were massaged every day so as to maintain the tone of the muscles and blood-vessels of the limbs.

An analysis of this case brings up the interesting problem of the cause of the sudden increase of the deformity and the resultant paralysis. The actual cause of the scoliosis is the extensive congenital malformation of many of the vertebrae. There can be little doubt, also, that the marked posterior curvature of the dorsal segment resulted in pressure on the cord and consequent paralysis. The more or less sudden increase of the deformity is not so readily explained. It occurred while the patient was taking a course of gymnastic exercises. It may be that the aggravation of the curvature was part of the natural course of this patient's deformity just as many other patients suffer at one time or another an in-

crease in their deformity. But, inasmuch as the deformity got worse while the patient was taking exercises, it is possible (I myself think that it is more than likely) that the increase of the curvature was due directly to the exercises. In common with others I have seen many patients become worse after they had been taking exercises and I believe that in some cases they have a harmful influence. This is due to the fact that mobilization of the spine and increase in the flexibility of the trunk permit greater relaxation and slumping of the body in the interval between the gymnasium periods, and the curvature increases. It is true, of course, that in the majority of instances gymnastic developmental and corrective exercises improve the muscle tone and the patients profit from this work and acquire the ability and habit of holding themselves in a better posture. But in *some cases*, undoubtedly a very small percentage, composed particularly of those with weak musculature and poor posture, the increased flexibility of the spine is detrimental and permits the spine to become more deformed. I have a boy of 18 under my care now who, tired of jackets, left them off and for over a year has been exercising every day. His curvature has greatly increased. Such an aggravation of the deformity is especially likely to occur in cases of single curves of rachitic or paralytic origin. I believe that in the case here reported, where the spine was unstable because of the extensive malformation of the vertebrae, the mobilization resulting from the exercises permitted an increase of the deformity of the spine. This and other experiences emphasize both the need of the strictest supervision of children who are being treated with corrective exercises, and the importance of employing some form of supporting corset until the time when the muscles are sufficiently strong and the improved posture has been retained for a long enough time to make it unlikely that the deformity will increase.

This case is interesting chiefly because of the rarity of paralysis as a complication of structural scoliosis. Dr. Ridlon reported two similar cases in the September 9th, 1916, issue of the *Journal of the American Medical Association* and in a personal communication to me, dated January 12th, 1922, he writes that Dr. Parker of Chicago has a similar case now under treatment. It is interesting also, however, because it suggests the probability that gymnastic exercises may at times be responsible for increase of the deformity. I believe that every patient with a well-marked scoliosis, who is taking exercises, ought to wear some form of supporting apparatus.

SYNOVECTOMY IN CHRONIC INFECTIOUS ARTHRITIS.*

BY PAUL P. SWETT, M.D., HARTFORD, CT.

During the period of 1915 to 1921, I have performed fifteen synovectomies on eight patients suffering with chronic infectious arthritis. These patients have been carefully followed, and I wish to present a clinical study of this small series of cases. The operation itself has consisted in opening the joint, generally, at the site of the greatest thickening and effusion, and then with scissors and forceps dissecting out all of the diseased inner layers of the synovial membrane down to what appeared to be healthy tissue. The joints have all been closed without drainage, and with no fixation.

In this study there has been an attempt to follow the Goldthwait classification, and no reference is intended, therefore, to chronic hypertrophic or chronic atrophic arthritis. The differentiation between the types naturally depends upon physical findings and radiographic manifestations, and such illustrations as accompany the case reports will help to establish the validity of the diagnosis.

The theoretical considerations leading to the trial of this operation were three in number. The first theory was based upon the proposition that the surgical foci of infection having been removed, the patient's general state indicating that the activity of the inflammatory process in the joints was subsiding, and the usual means of absorption of the organized inflammatory exudate having failed, there remained the possibility that the manual removal of the exudate might promote the resumption of joint function.

The second theory, which developed later, was that the same procedure might be helpful, not alone by the mechanical improvement, but by reason of the fact that the organized synovial exudate contained microorganisms which were capable of continuing the activity of the process within the joint as well as causing metastases into other and previously uninvolved joints. As a natural corollary to this proposition, it would seem that if one grants the existence of secondary metastatic foci within the joints, there is as much logic in their surgical removal as there is in the elimination of the originating or portal of entry foci. Moreover, since it seems to be true that there is a duel going on within the patient between infection on the one hand and resistance on the other, and since,

*Read at the meeting of the American Orthopedic Association, held at Washington, D. C., May 1-3, 1922.

FIG. 1.—CASE 1. N. B. Antero-posterior view of right knee, six years after the first operation. Note the absence of bony changes.

therefore, the final reaction depends in the last analysis upon the patient's resistance, it naturally follows that the less the amount of infection, the better the prospects of ascendancy on the part of the patient's resistance.

The third theory, which has seemed in some ways to lend further encouragement to the possibility of benefit from synovectomy, has been initiated by Pemberton's work on Metabolism in Arthritis. As I understand it, he has found in his chemical studies that the arthritides show a fairly constant suboxidation process and, apparently, the persistence of this abnormal metabolic state prolongs the arthritis. Hence, one of the aims of therapy must be to stimulate the metabolism, and perhaps the best means for accomplishing this purpose consists in a prompt restoration of function in atrophic disused joints and muscles. If the manual removal of diseased synovial tissue can hasten the restoration of function, it may thus indirectly provide the necessary metabolic stimulant.

The cases, with one exception, were all of long standing, showing

FIG. 2.—CASE 1. N. B. Lateral view of right knee six years after the first operation. Note the absence of bony changes.

marked joint effusion, capsular thickening, and fusiform swellings. The interior of the joints showed the large collection of synovial fluid occasionally cloudy and in two instances pus-like in consistency. The synovial membrane was thickened and dense; sometimes so dense as to cut like cartilage. Organized exudate was always present either in the form of large villous tabs or fringes, or as a pannus extending over the articular surfaces, or as a dense, tough membrane walling off the capsule into compartments. The joint cartilages showed no ulcerations except in one case, and in this the operation was a failure in every way. With this one exception, therefore, it seems evident that the process began in the capsule of the joints, and that the synovectomy was done before any damage had occurred in the cartilage. Moreover, the principal synovial changes were found at a distance from the articular margins. This last feature seems to point to the assumption that there must be a type of chronic infectious arthritis or a period in the development of this disease in which the damage is entirely synovial, and cartilaginous injury is not present. Apparently, this type or stage is clinically distinguishable by

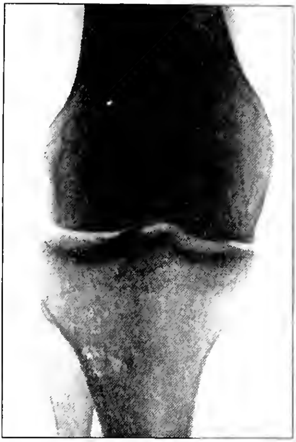

FIG. 3.—CASE 2. A. D. Antero-posterior view of right knee, four years after operation. No evidence of atrophic or hypertrophic changes.

the extensive effusion and fusiform swelling often accompanied by heavy grating on motion or deep palpation. The pathological reports showed chronic inflammatory tissue, and negative cultures were returned in all of the cases. Micro-organisms were found in the stained specimens in only one.

Mechanical improvement in the operated joints was promptly manifested by a restoration of painless function in every case, but in two a relapse occurred very shortly, and in one of these two, re-operations were performed with ultimate, complete recovery. So it may be said that only one was a failure, and that twelve were successful from the point of view of joint mechanics. It is to be noted that the one complete failure occurred in a case which presented certain features differing from the usual type inasmuch as a spondylitis was present in this one case, and in the knees the cartilages were covered with small spots of active red granulations.

These few cases offer very little evidence as to the effects of synovectomy on the general arthritic process, but so far none of the patients

FIG. 4.—CASE 2. A. D. Lateral view of right knee, four years after operation. No evidence of atrophic or hypertrophic changes

has developed any extension to previously uninvolved joints, and six of them have been able to resume their former occupations. Of the remaining two, one was a bedridden cripple, and she is now able to care for herself, while the other is actually worse. With this one exception, all of these patients have gained in weight and strength, and have recovered from their anemic, febrile states, but there is no way of telling whether these changes might not have occurred spontaneously.

A synopsis of the case history of the first patient in this series may help to visualize the type of case.

N. B. Age 19. Austrian. Domestic servant. Admitted to the Hartford Hospital, August 17th, 1915. Complaint: rheumatism. Present illness began in 1911—four years before admission—with inflammation in the mid-joint of the right ring finger. After two years, the process appeared in the right wrist. In another six months the left wrist was involved. Beginning six months ago the same condition began in both

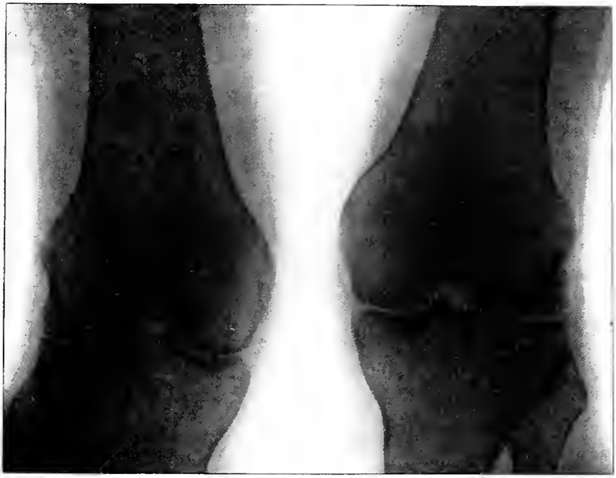

FIG. 5.—CASE 7. J. J. Antero-posterior views of both knees, about two years after operations. The cartilaginous spaces are small but there are no gross evidences of atrophic or hypertrophic changes.

ankles and both knees. A tonsillectomy was performed about the time the last-named joints were affected. When I first saw her there were all the typical features of a severe chronic polyarthritis involving the hands, wrists, knees, and ankles, with marked effusion in both knees. Constitutionally, she presented loss of weight, moderate anemia, slight temperature, and rapid pulse. No surgical focus of infection was discovered. X-rays of the knees were negative for bony or cartilaginous changes. She was bedridden and helpless. Aspiration of the knees yielded cloudy, yellow fluid, culture from which was negative.

The right knee was opened on Sept. 8th, and it was found to be filled with a pannus-like layer of granulation tissue extending over the entire upper portion of the synovial membrane. This was removed with scissors down to healthy tissue, and the joint was closed without drainage. No postoperative disturbance occurred, and the left knee was similarly treated about five weeks later. She was able to get up in the course of two weeks, and began walking with crutches immediately. She was sent to her home on Nov. 6th, where she gradually increased her activities.

and in June it was noted that there was no effusion in either knee, and no signs of activity in any of the other joints. During the summer she resumed her full work as a domestic servant, her weight and general tone were normal, and she continued well until June, 1918, when a relapse occurred in the left knee. This was manifested by an extensive effusion, marked crepitation, and painful, restricted motion. The disability was so great that she returned to the Hospital, where a second partial synovectomy was done in July, and she remained in the Hospital until September. She was well from then until January, 1920, when effusion gradually occurred in the left knee again. In March an extensive synovectomy was performed, and she has remained entirely well since then—now over two years. On every occasion when diseased synovial tissue was removed, it was sent to the laboratory to be sectioned, and to have cultures made. The laboratory reported it as inflammatory tissue, but no culture growth was ever obtained.

I hesitated to suggest another operative attack upon the left knee, but the patient requested it, and spared me the embarrassment. She had been helped so much by the former operations that she had every confidence in the success of another. Her judgment seems to have been substantiated, for on the last examination, March 30th, 1922, both knees presented complete extension, complete flexion, no effusion, and no thickening. The ankles and feet were normal. She had a full range of motion in both elbows, the right showing considerable thickening. There were no signs of activity in any of the joints of the hands or in the wrists, although both wrists were completely ankylosed. Her weight was ninety-three in 1915, and her present weight is a hundred and forty-seven.

To recapitulate, then, it may be pointed out that here is a case of chronic polyarthritis which showed no improvement five months after the removal of the probable focus of infection. Double synovectomy of the knees was followed by a prompt local improvement so great as to enable her to resume her work as a domestic within a few months. Accompanying the local improvement, a general improvement was made, and the inflammation in other active joints became arrested without any direct treatment. This patient has been presented before several members of this Association, and they can testify as to her robust state of health.

I propose to give a very brief résumé of the important parts in each of the remaining cases of the series, having in this fuller account of the one case established in your minds the type of case in which synovectomy has been undertaken.

CASE 2. A. D. Age 38. Female. Lady's-maid. In 1910, she had an effusion in the right knee which was treated by incision at the Charing Cross Hospital in London. The present attack of polyarthritis began in March, 1915, involving hands, wrists, feet, and knees. Tonsils, adenoids and diseased teeth were removed. She made a gradual improvement up until 1918, and was able to do her work, but then her right knee became so painful that she came under my observation. In September, 1918, I did a synovectomy on the right side. Normal function of the right knee returned, and all of the joints improved. The appearance of the interior of the right knee-joint at operation was interesting, as the very large, thickened inner portion of the synovial membrane had formed actual bridges across from the anterior to the posterior portion of the upper parts, walling off several compartments, and effectively restricting motion. A year and a half after the synovectomy, the left knee was similarly involved, and a synovectomy here was followed by excellent results.

She was last observed on April 6th of this year, and she was in good general health, actively at work, the knees being painless and freely movable.

CASE 3. C. C. Female. Age 55. First seen in May, 1919. She had suffered an attack of infectious polyarthritis three years previously. The condition, after removal of diseased teeth, gradually subsided, and all of the joints cleared up except the left knee. Before she was discharged from the Hospital, the left knee was aspirated three or four times, and she appeared to recover. About one and a half years later, however, she began to have recurring febrile attacks with acute pain and effusion into this knee, the attacks coming every few weeks. A synovectomy was performed on the 20th of May, 1919, and a considerable amount of organized exudate was found. In the upper outer quadrant there was a walled-in area containing thick, yellow, pus-like material, culture of which was negative. At the last examination, April 5th, 1922, the knee showed extension to 180° and flexion to 90°, no effusion or thickening. There had been no recurrence of the acute attacks, and she walked well without support.

CASE 4. F. L. S. Male. Age 29. Polyarthritis began in 1912 with sudden onset in the right knee. The knee was drained by his own physician at this time. A year later, the left knee, fingers, shoulders and feet became involved, and two years ago the right knee. Diseased tonsils and diseased teeth had been removed when I saw him. All of the

involved joints showed signs of considerable active arthritis, fusiform swellings, distention of the capsule, crepitation and limitation in motion. The general picture was that of an ill, thin, under-nourished young man. Both knees were subjected to synovectomy, and a large amount of organized exudate and villous material covering the inner surfaces of the synovial membrane in the upper portions was removed. Three months after the operation it was noted that his general condition had improved. There was no effusion in the right knee, and a full range of motion was present. There was a slight amount of effusion in the left knee, but no restriction in motion, and pain was very much less severe than before the operation. One year after the operation, all of the other joints were much improved, and his general condition was vastly better, but there still remained a little effusion, crepitation, and restriction in motion of both knee joints.

CASE 5. J. M. C. Male. Age 50. Sudden onset of severe acute polyarthritis in October, 1920. The right knee, the hands, and both shoulders were involved. Very badly diseased tonsils were removed about two and a half months after the onset of the condition. All of the joints promptly quieted down except the right knee, which seemed to be improving under local protection and baking and massage. In the fall of 1921, the knee became less movable, more swollen and more painful, and one of my colleagues performed an extensive synovectomy, and he reported to me in April, 1922, that the patient was in exellent health, with a freely movable and painless right knee.

CASE 6. M. P. Age 15. School-boy. October, 1918. Polyarthritis involving the right elbow, right wrist and both feet, five months' duration. Five years previously he had sustained an acute attack of arthritis in both knees, which entirely cleared up. There was a great deal of capsular thickening in the right elbow. A tonsillectomy and synovectomy of the right elbow were done at the same time. Six months later, he presented an entirely different appearance. There was no swelling in any of his joints, and he had complete motion in his elbow and wrist, and his general condition was excellent.

CASE 7. J. J. Age 32. Swedish. Domestic. Admitted to the Hartford Hospital, June, 1918, very much crippled with a polyarthritis of four and a half years' duration, involving hands, elbows, shoulders, knees, and feet. This patient was admitted on the Medical Service, and shortly thereafter transferred to the chronic female ward, where she led a mis-

erable existence between a bed and chair. The involved joints were pretty well fixed; the knees were flexed at a right angle. She had to be lifted into a sitting position. In December, 1918, a double synovectomy was done at one sitting, and within the course of a few weeks it was possible for her to get in and out of bed unassisted. She gradually resumed the upright position, and in the course of six months she was able to walk without support, and so far as her knees were concerned, she made a wonderful recovery. There was so much restriction in motion in her shoulder-joints that she was very much hampered in assisting herself to dress and bathe, etc. She was finally discharged from the Hospital, however, in December, 1921, able to return to her sister's home, and get about and wait upon herself in every way.

CASE 8. M. T. B. Age 23. First seen in October, 1915. A very extensive chronic effusion in both knee-joints of several years' duration. I aspirated both knees, and injected formalin and glycerine, and the effusion did not return, and the patient was able to resume his work, and he got on very comfortably until four years later, when he reported that the effusion had recurred in both knees. They were again aspirated, and apparently benefited. The patient returned again in the spring of 1921, and this time there was not only an extensive effusion in the knees, but a beginning spondylitis. A synovectomy was done, but the picture in the interior of the joint in this case was quite different from what had been found in any of the other cases. There was no pannus-like exudate, the inner surfaces of the synovial membrane were red and injected, and over the cartilaginous portions there were small spots of active granulation tissue. These were wiped off, and the joints were closed, but no improvement whatever resulted, and the patient reported in April, 1922, that his knees were very stiff, and that he was practically disabled.

The summary of the important points brought out by this series of cases is as follows: No local damage or disastrous complications have followed the operation; very little reaction, either locally or constitutionally, has been found postoperatively. With one exception a marked improvement in the mechanics of the operated joints has occurred. In six of the eight patients, the operation was followed by a pronounced general improvement, and apparently accompanied by some amelioration of the signs and symptoms in the other involved joints. In one case, there was no improvement whatever, either locally or constitutionally, and in one case the local and constitutional improvement was very slight. It seems to me, therefore, that synovectomy is a procedure which warrants further consideration in cases of chronic infectious arthritis.

and that if the cases are carefully selected, so that the operation is not attempted in other forms of polyarthritis or in cases in which extensive cartilaginous damage has already occurred, we may expect local benefit to follow. A word of warning must accompany any such conclusion, however. This operation cannot, I believe, take the place of other forms of treatment, and it should not be resorted to on any wholesale basis. It should not be undertaken in any case in which the diagnosis is not perfectly clear. Moreover, it should not be undertaken until the originating foci of infection have been eliminated, and sufficient time elapsed to show that improvement cannot be secured by such conservative constitutional means of treatment as are generally practised. Apparently, the operation is most likely to succeed if it is done in the type of case or at the stage of the disease where the damage is entirely synovial, the effusion extensive, and the cartilages are not ulcerated.

DISCUSSION OF DR. SWETT'S PAPER.

Dr. Frank D. Dickson, Kansas City, Mo.: I had the opportunity about a year ago of examining two of Dr. Swett's patients, and I want to give personal testimony to the very excellent results which he secured in these cases. I myself have been interested in this operation of synovectomy in arthritic cases. I have been interested in the question of whether in these synovitis and arthritis cases the joints are not the source, as Dr. Swett mentioned, of active bacterial infection, just as the tonsil or apical abscess in the teeth can be the source of infection; in other words, whether the joint infection may not have been secondary to start with and became the primary source just as may be the case in any other infection. With that end in view, we endeavored to get cultures from all the infected tissues, at the operating table. One case with some points of interest was that of a man who had been treated in the clinic for arthritis. I felt it was a question of an infectious arthritis. I had him examined by an urologist. He gave a history of gonorrhea fifteen years before. The urologist reported that his seminal vesicles were full of pus, and he advised drainage. They were drained, and I am sorry I did not show him after that drainage to some of the members of the Central States Orthopedic Club, who were in Kansas City last fall. Immediately after the drainage there was marked improvement in his elbow, back, and neck. He had not been able to lie down for three years, except with pillows piled under his shoulders. After the drainage he could lie flat in bed. His right knee continued swollen, and I went in as Dr. Swett advocated. There was a tremendous amount of synovial hypertrophy. The joint seemed to be divided into several compartments. Tissue was taken from the joint, and several cultures made on glucose agar aerobically and anaerobically. We got a growth in those cultures anaerobically. They were carried through from one inoculation to another, from the 17th of December, and were still alive January 18th. The report of the pathologist was that the cultured organism was probably gonococcus. An attempt was made to reproduce this condition in rabbits and various other animals, but we failed there. These experiments are incomplete, but there seems to be no question

that in this joint there were bacteria present, because numerous cultures were made, and they all follow out. We carried them through as far as reproducing the condition in animals. The cultures from the joint contained bacteria which resembled the gonococcus culturally. The man has continued to improve and has pretty nearly normal function in the knee, and is back at work.

I have tried in several other cases without success, for there are a great many difficulties encountered in getting cultures made which will grow. It is only by care that we succeeded at all. I hope to continue along this line, and have something to report next year. There is something to indicate that these synovial hypertrophies may contain in them definite bacterial foci, which may continue to produce changes. I might relate one case. I had done a synovectomy, and in closing up the skin I used a pair of pointed scissors, and punctured my glove with the tip of the scissors. These had been used for only one purpose—to dissect out the synovial tags. In six hours I had the most beautiful cellulitis up my arm. This is not very scientific. The table was sterile, and the only thing I touched was the tip of the scissors that I had used to clean out the synovial membrane.

Dr. J. O. Wallace, Pittsburgh: I saw Dr. Swett's cases at Hartford, and I want to say that he is doing good work. There was one patient that I remember who was very much crippled, and who was getting around apparently without any pain. I myself have operated on one case since, a man with both knees and one ankle involved. There was swelling above and around the knees. I opened up one six months ago and took a culture. There was no growth after seventy-two hours, but the report of the pathologist was acute and chronic inflammation. I did the second knee about ten weeks ago. This man has improved in his general condition. I think the good that is obtained from this operation is the removal of a great, large area of diseased tissue.

Dr. Paul P. Swett, Hartford, Conn. (closing the discussion): I have nothing to add except with regard to the question of lippings of the articular margins, which Dr. Watkins spoke of. I think one should distinguish if possible between lippings that are caused simply by the mashing out of cartilage, and the lippings produced by actual bony overgrowths that one sees in hypertrophic arthritis. As far as I can see, there is no rational basis for this procedure, except in the purely infectious type of arthritis.

CONGENITAL ELEPHANTIASIS OF THE TOES.*

BY HARVEY S. THATCHER, M.D., AND THOMAS WHEELDON, M.D., RICHMOND, VIRGINIA.

Hypertrophy of the extremities has been designated by various titles. Some of these terms are lymphangioma, congenital hypertrophy and dilatation of the lymph channels, lymphangiectasis, elephantiasis, etc., depending upon the main pathological change. In reviewing the literature since 1878 many superficial reports have been made without microscopic verification; therefore the exact change could not be determined.

History:—The patient was a colored boy, twelve years old. The third and fourth toes of the left foot had been swollen since he was one year old. There were alternating periods of swelling and tenderness. Upon physical examination the third and fourth phalanges of the left foot were swollen, indurated, and thickened.

X-Ray Description:—Dr. A. L. Grey states that the phalanges of the second row of the outer four toes have only one center of ossification. The metaphysis of the first phalanx of the fourth toe has a developmental irregularity. The bones of the hypertrophied toes are not different from the others. The hypertrophy is confined to the soft tissue.

Operation:—Because of the severe pain, Dr. Graham amputated the third toe.

Pathological Description:

Gross changes:—The toe is much larger than normal (measuring 5.2 cm. by 2.7 cm.), and soft. The surfaces made by sectioning are whitish grey.

Microscopic changes:—There is an increase in the number of sweat glands, adipose tissue, connective tissue, blood-vessels, and nerves, compared with the normal. The various strata are also increased in thickness, especially the epidermis. There is a slight infiltration of lymphocytes.

Discussion:—These hypertrophies may be congenital or acquired. The phalanges only are affected. There must be a congenital defect because the centers of ossification are absent. Virchow considered bone hypertrophy as an occasional lesion. There are no bone changes in the case described.

Conclusions:—There is hypertrophy of the soft tissues.

The evidence suggests a congenital origin.

*From the laboratories of Memorial Hospital, Richmond, Va.

THE CONSERVATION OF MUSCLES IN PARALYTIC DEFORMITIES OF THE FOOT.*

BY PERCY WILLARD ROBERTS, M.D., NEW YORK.

As a result of several years of clinical study I am of the opinion that the field of muscle conservation in deformities of the foot following poliomyelitis is one in which much constructive work still remains to be accomplished. We are, I think, too often content to regard a muscle which has not functioned for several years as hopelessly paralyzed, and, as a logical sequence, we are too ready to resort to ankylosing or tendon-mutilating operations as the best solution of an unfortunate situation.

It seems to me that the problem of the paralytic foot in the child is not merely one of overcoming the deformity, but of correcting it by such means as will leave the least handicap to the social and economic progress of the patient in later life.

Obviously, if this objective is kept in view, a stable, flexible foot is more to be desired than one which functions without elasticity. The stiff foot may be a useful member so far as locomotion is concerned, but it compels certain limitations of activity which must necessarily leave an imprint on the development of the individual.

To illustrate my point let me outline three cases. The first is that of a school teacher of twenty-three who for more than twenty years had limped through life with an extreme calcaneus deformity, and in her home town was known as the "teacher with the lame leg." As there was no apparent power in the calf muscles on the affected side I advised astragalectomy. During a subsequent examination, however, I observed that the flexor hallucis and common flexor were strong, and, applying a theory which will be discussed later, I suggested that we try the experiment of shortening the tendo achillis. It was made clear to the patient that this would mean the use of a splint to protect the gastrocnemius from strain for at least a year and also an indefinite period of muscle training. The tenoplasty was done and the after-treatment faithfully carried out. Three years after operation this young woman's calf measurement had increased over two inches, and she now walks in low shoes without perceptible limp. She is no longer called the "teacher with the lame leg."

*Read at the meeting of the American Orthopedic Association held in Washington, D. C., May 1-3, 1922.

The second case was that of a woman of thirty-two, who for thirty years had worn a brace for a paralytic equino varus of extreme grade. She had no control over her foot except slight flexion and extension of the toes. To all who saw her walk she was a conspicuous cripple. On my history card of this case I have recorded that astragalectomy was advised. By the time she came for operation, however, I had observed the result in the case just cited, and therefore it was decided to lengthen the tendo achillis and remove a wedge from the outer border of the tarsus to correct the varus. Two years have passed and this patient now has a good foot with a very fair range of voluntary motion, and she is able to wear an ordinary shoe. Her mental attitude toward life has been strikingly altered for the better because she no longer considers herself a cripple.

The third patient, a large boy of sixteen, was in the Hospital for Ruptured and Crippled three years ago. He had a marked paralytic varus of twelve years' duration. Previous surgical measures having been followed by a recurrence of the deformity, he was scheduled for a radical bone operation. At my request, Dr. Gibney was good enough to revise his initial decision and consented that I should lengthen the tendo achillis and shorten the peronei. A year later the boy became a leader in school athletics, excelling in baseball and basketball. The psychological effect of changing an ambitious youth from a crippled observer to a successful contender in strenuous games needs no comment.

All of these cases were instances of stretched muscles, which, though functionless for from twelve to thirty years following attacks of poliomyelitis, were not paralyzed. There can be no doubt that these patients are happier and will develop along more normal channels than if they had been subjected to the ankylosing operations at first contemplated, which would have resulted in definite limitation of their activities.

The dictum of the firm, restricted foot has guided us in our choice of operation in paralytic deformities largely because there has been no generally recognized means of foretelling the possible return of power to functionless muscles. Profiting by the cases cited and by others of similar nature, I have formulated two simple theories which, if not infallible, are nevertheless of distinct service in solving the riddle of latent power in muscles which have long been inactive.

The first of these is the self-evident truth that a muscle which does not function after an attack of poliomyelitis is not necessarily permanently paralyzed, and the second, that where a group of muscles is supplied by the same terminal nerve no one member of the group is

likely to be completely paralyzed if the others have gained approximately normal power.

These theories have been applied in about one hundred operated cases with results which indicate a very practical degree of dependability. They have, indeed, been responsible for the development of a most satisfactory operation for a certain type of paralytic valgus, to which I particularly desire to call your attention, and also for some work on calcaneus deformities which may be referred to in passing, although the study has not proceeded far enough to warrant definite conclusions.

There frequently occurs a type of valgus deformity in which the tibialis anterior is functionless, and in the movement of dorsiflexion the foot is drawn outward by the action of the common extensor in spite of vigorous effort on the part of the extensor hallucis to maintain the median position. It will be observed that we have here one muscle, the tibialis anterior, apparently paralyzed, with the other two of the group supplied by the deep peroneal nerve functioning well. Applying the theories just referred to, we assumed that under such circumstances the tibialis was probably not hopelessly paralyzed, and that its inability to function was due to the fact that it had been stretched and had suffered from the atrophy of disuse. It was further assumed that shortening the tibialis and transplanting the common extensor to act upon its tendon would restore the stability of the foot.

Putting these assumptions into practice, we have evolved an operation at the Hospital for Ruptured and Crippled known as "reinforcement of the tibialis anterior." In sixty-six cases treated by this method on the Second Division of the Hospital by twelve different surgeons the results have on the whole been so satisfactory that the operation has become routine practice in all valgus cases where the common extensor and the extensor hallucis have regained a serviceable amount of strength. There results from this procedure a well-balanced foot, and it has been interesting to note that two or three months after the splints are removed definite return of contractility can be demonstrated in the tibialis muscle.

In cases of calcaneus deformity the problem is more difficult, both because there are no other muscles on the posterior aspect of the leg which approximate the gastrocnemius and soleus in strength, and because development of the latent power of functionless calf muscles requires many months of intelligent coöperation on the part of the patient. However, I am satisfied from my experience with "the teacher with the lame leg" and from several cases in which reinforcement of

the calf muscles has been successfully accomplished, that there are a very considerable number of instances in which conservation of the posterior muscles will give an ultimately more useful foot than any form of ankylosis.

Success in our effort to reinforce the calf muscles will depend somewhat upon the ability of these structures to regain a portion of their normal contractility when suitable mechanical relations are established. That a useful amount of power may return to the calf muscles appears certain from the results disclosed in the examination of a series of 25 cases in which astragalectomy had been done from six months to nine years previously for calcaneus deformity. It was found that in cases where there was no voluntary control of the toe flexors there was likewise no control over the calf muscles. On the other hand, where the flexors of the toes were active there was a return of power in the gastrocnemius which could be rated from fair to excellent, and there was usually a definite relationship between the strength of the two muscle groups.

These observations lend support to the theory that a muscle which does not function after an attack of poliomyelitis is not necessarily paralyzed, and also to the contention that no single muscle of a group supplied by the same terminal nerve is likely to be completely paralyzed if the other members of the group have regained nearly normal power. In practice I believe the application of these principles will be of service to those who are interested in the conservation of muscles in paralytic deformities of the foot.

A VISIT TO SOME OF THE ORTHOPAEDIC CLINICS OF EUROPE.

BY ARTHUR STEINDLER, M.D., F.A.C.S., IOWA CITY, IOWA.

MILAN.

THE OSPEDALE MAGGIORE at Milan is an enormous institution which contains 3,000 beds. It is planned on the pavilion system, the mechano-therapy being housed in one of the pavilions. I found this department extremely well-equipped with Zander machines and other mechano-therapeutic implements of all sorts. The physician in charge devotes his entire time to mechano-therapy and physiotherapy, and his patients are assigned to him from all departments of the house as well as from the large out-patient clinics of the hospital.

The Istituto dei Rachitici of Milan is one of the two largest orthopaedic institutions in Italy. Situated on a quiet and unobstrusive thoroughfare, the Via Vigentina, it is modestly hidden from open view by a number of doorways and courts which have to be crossed before the main buildings of the institution are reached.

It was founded in 1881 and was then the second orthopaedic institute in Italy, following closely that of Turin. The first funds for the maintenance of this institution were raised as early as 1850, with the avowed purpose of constructing an orthopaedic hospital for crippled children. The main building was erected in 1881, and has been greatly enlarged since that time. Professor Ricardo Galeazzi, the present Director, is the successor of Panzeri, ably assisted by Professors Bassetta and Scarlini, as well as by the Assistant, Dr. Guido Nastrucci. Professor Galeazzi's work is recognized as among the best in Italy. Through the courtesy of Professor Galeazzi and Dr. Nastrucci, the writer was able to gain quite an accurate insight into the activities of this institution. It is laid out in the pavilion system, and has a capacity of 250 to 300 beds. The center pavilion serves for operating suites, for the plaster of paris work, the radiography, photography, and for the care of postoperative cases. Another pavilion is devoted to postural gymnastics as well as the department of scoliosis, which has a special gymnastic equipment and special record rooms.

There is also a pavilion for adult men, one for adult women, and one for children of both sexes. One pavilion is devoted to pathological laboratories, another to the school work, social activities, and dining

rooms. Other pavilions again harbor the so-called *pensionisti*, or pay cases, which seem to be part of the hospital contingent in the Italian institutions which the writer has visited.

Although Milan has no undergraduate medical school, intensive post-graduate teaching is carried out by a chain of institutions called Istituti Clinici di Perfezionamento, the Istituto dei Rachitici being among this chain of institutions which serves the post-graduate teaching.

The writer was particularly interested in Prof. Galeazzi's method of correction of scoliosis. Following Dr. Lovett's principle of correcting the deformity in forward flexion of the spine, Galeazzi has developed an excellent technique of plaster of Paris application, facilitated by the use of a special apparatus constructed by himself, which serves for the fixation of the pelvis as well as the trunk, and which allows rotating the pelvis and trunk in different directions.

The cast is applied in two sections, one section encasing the shoulder, and the other the pelvis. When the desired position of rotation is obtained both for the shoulder and the pelvic girdle, the two sections of the cast are then united by plaster of Paris. As the writer had occasion to satisfy himself, when this method was demonstrated, the patient experiences very little suffering during this procedure, and his physical condition, especially his pulse and respiration, remains good.

The results of the method were most courteously demonstrated on patients as well as by lantern slides. While there has been no true over-correction of the curve in the anatomical sense, the cosmetic effect of the method has been, to say the least, striking. The fenestration of the cast is very much the same as in Abbott's method. Two or three casts are applied at intervals of one month, the total average time of fixation being about four months. Felt pads are inserted over the costal prominence, in the back, and in front, through windows, as in the Abbott method. The particular advantage of this method seems to the writer to lie in the more accurate plaster technique, in the more efficient rotation of both pelvic and shoulder girdle by means of the special apparatus, and, lastly, in the much greater degree of comfort which the patient enjoys.

Following the plaster of Paris period, a celluloid brace is worn for half a year, and vigorous scoliosis exercises are begun at once. The latter are extended for a period of from one to two years.

The material of Prof. Galeazzi amounts to about 100 cases a year.

BOLOGNA.

THE ISTITUTO ORTOPEDICO RIZZOLI.

Francesco Rizzoli was one of the most famous professors of surgery of the University of Bologna. The Istituto Rizzoli owes its existence to the noble generosity of this man, who donated his entire fortune to the creation of a great orthopaedic institute to be located in the old monastery of the Olivetan monks. In 1880, he bought the site of the present hospital with the old monastery situated on top of the most picturesque of a chain of hills south of the city, called San Michele in Bosco.

At the expense of one and one-half million lire and by an effort of fifteen years, this magnificent old historical structure was finally adapted for its new purpose. The first director of the institution was Panzeri, who at the same time filled the directorship of the orthopaedic institute at Milan. But it was under Alessandro Codivilla, the father of modern orthopaedic surgery in Italy, that the Institute rose to the highest scientific level, which it has maintained undisputably to the present day. After a short administration under Cesaro Ghillini, the Institute is now finally in the hands of that most brilliant and ingenious of all living orthopaedic surgeons in Italy, Vittorio Putti.

In adapting the building for its present use, the needs of a modern and scientific institution have been most happily harmonized with the aim of preserving the old historical charm and beauty of the building. Situated upon a hill and within short distance from the city, it commands an incomparable view over one of the most beautiful cities of Northern Italy.

The building encloses two great courts laid out in Italian style, one of them being named after its founder. The long porticos facing the courts as well as the front of the building, lead to rooms and halls of dimensions quite unknown to our American plan of hospital construction. One of the halls is 160 meters long, and may be closed in with glass during the colder season. As the latest concession to modern hospital equipment, Prof. Putti tells me that he has introduced the American fly-screened windows.

The rooms for the patients are large, light, and airy. There is an orthopaedic gymnasium, most excellently equipped with Zander machines and other apparatus. The abundance and variety of this equipment the writer has not seen equalled in any other institution. In the scoliosis rooms, one may find one of the very few Schulthess scoliosometers in existence, together with other original Schulthess machines.

The old refectory of the monks houses the pathological museum, which contains many interesting specimens of bone pathology, beautifully arranged in glass cases.

The library of the Institute, which is essentially an orthopaedic library, contains a very large number of volumes, and among these, some very valuable antique editions. All modern orthopaedic journals and most of the leading medical journals in general are represented. A special librarian is employed whose duties are not only the ordinary duties of a library custodian, but who also, I understand, is capable of lending a helping hand in the extensive literary work which is always carried on in this institution. Professor Putti's activities as editor of the leading orthopaedic journal of Europe are such that the efficiency of an orthopaedic library must be put to a rigid test.

THE SHOPS.

The orthopaedic shops of the Istituto Rizzoli are the largest and the most completely equipped of any which the writer has had occasion to see. These shops are contained in four very large sheds, and it is stated that more than 100 workers, most of them skilled mechanics, are employed. A technical director is in charge of the technical work, and he is assisted by a commercial director who takes care of the distribution and sale of the products of this shop, which serves not only the needs of the institution but which sends out its equipment and artificial limbs over the entire kingdom. The work is divided into a department for artificial limbs, one for brace work, one for the manufacture of instruments and tables, each one of these divisions being housed in a separate building. Among the many new instruments, the writer admired especially the new table of Putti. This is a most ingenious piece of machinery, extremely suitable for the application of all kinds of plaster of Paris casts. The exactness of its construction and the versatility of the use of this table places it above any others I have seen. As regards the artificial limb work, the profession is well acquainted with the newer constructions, especially the splendid types of upper extremity prosthesis which have been developed by Putti, Delitala, and other Italian orthopaedic surgeons. One may see them here in all stages of evolution, and one cannot help but be impressed with the precision of the work which penetrates every detail. A good deal of use is made of celluloid braces which are manufactured with, one might say, an artistic finish; especially celluloid torsos and body braces of different types seem to be very generally in use. In the special division devoted to orthopaedic instruments, the writer's interest was engaged by Putti's

osteotone, an instrument which he described some time ago in connection with the technique of lengthening shortened bones. To this group of instruments belong also the so-called osteo-synthetic outfit and his chisels and files used for arthroplasty.

A whole afternoon spent in inspecting the diverse activities of this shop work seemed none too long a time and a very well paid effort, in view of the many new and interesting things that could be learned.

It has been the writer's good fortune to see Professor Putti operate on a number of interesting cases.

An arthroplasty of the elbow was done on a woman of 23 for ankylosis of this joint following gonorrhea. A semi-curved incision was used, starting laterally and encircling half the elbow, somewhat similar to the incision used by Ashhurst. A great deal of care and precision is given to the dissection and the modelation of the bone, more resecting being done from the end of the ulna than from the humerus. The head of the radius was also carefully freed and stripped of its attachments. After shaping the bones, they are carefully filed and smoothed, and a strip of fascia lata taken from the thigh of the same side is used to cover the head of the humerus as well as the head of the radius. The sutures are especially carefully carried out. The plaster of Paris cast which is subsequently applied fixes the limb in acute flexion and semi-pronation.

A child of six was operated upon on the right foot for paralytic equino-valgus deformity. Here the method of tendon sheath exchange was used. Through an anterior incision in front of the tibia, the extensor communis and tibialis anticus were isolated. Through a second incision made over the metatarsus, the extensor communis was divided over the middle of the metatarsal bones, and the peripheral ends were sutured to the extensor digitorum brevis. Then the central portion of the extensor communis longus was led out through the anterior incision in front of the tibia. Then the sheath of the tibialis anticus was opened and through this opening a guide was passed downward and carried out through a third incision made over the insertion of the tibialis anticus. Through this guide a double catgut suture was now passed upward, the tendon was attached to its sling, and finally it was led out through the incision over the tibialis insertion where the tendon of the extensor communis was finally fastened. In conclusion, the plastic lengthening of the tendon of Achilles was performed and all incisions were closed. Although the operation required four incisions, only 20 minutes were consumed in its completion.

The same patient was operated upon on the other leg for calcaneo-valgus deformity, and here a method entirely new to the writer was

applied. Through an anterior incision, both astragalus and tibia were laid bare. Then, with the motor saw, a quadrangular piece of the tibia one and one-half inches long and about one-fourth of an inch wide was resected. Next the chisel was driven horizontally into the body of the astragalus, making a cleft which was pried open wide enough to receive the resected piece of the tibial graft. This raised the anterior portion of the body in such a way as to inhibit dorsal flexion of the foot. The check on the dorsiflexion immediately after the operation was extremely complete.

For the relief of contracted hip in infantile paralysis, myotomy was undertaken from an incision similar to that of Smith-Petersen. In addition to the stripping and section of the contracted structure as it is done in Soutter's operation, Putti proceeds to the exposure of the contracted anterior capsule, which he believes is very often inhibiting the complete extension. An operation for traumatic saddle-nose was performed with consummate skill, although it was a rather simple procedure, consisting merely in the insertion of a previously made ivory prosthesis. The cosmetic effect of this operation, which took hardly more than 10 or 15 minutes, was striking.

Among a number of cases demonstrated after operation, the writer remembers especially two cases of arthroplasty of the knee which were additional to those already demonstrated by Putti in 1921. The first of these two cases was a man who had received a gunshot wound in the knee resulting in complete ankylosis. It was then three and one-half years after his arthroplasty. The second patient whose knee had likewise become ankylosed, following gunshot wound, was 9 months after the arthroplasty. Both patients showed a range of motion of 70 degrees, absolute lateral stability of the knee; in one case there was complete, and in the other almost complete active extension. Both patients walked perfectly.

It was also of interest to note the large number of cases of congenital dislocation of the hip which are operated upon in this institution. While this deformity is almost unknown among the southern Italian races, it is very frequent in northern Italy. So far as I am able to learn, the treatment is quite uniform in the different Italian orthopaedic clinics. The matter of reduction is the bloodless method of Paci. The post-operative fixation averages only 4 to 5 months, during which time two or three plaster casts are used. When the last cast is removed, fifteen days of rest in bed are allowed, during which time the hip is held immovable by sandbags. The casts are applied with the hip in

inward rotation in the majority of cases. After the period of bed rest, walking is allowed and massage is begun.

The treatment of scoliosis is based mainly upon corrective casts applied in extension and followed by scoliosis gymnastics, for which the splendidly equipped gymnasium offers ideal facilities. It has been the writer's great regret that the short time of his stay would not permit him to study all the different methods applied in this institution, but whatever he has had the good fortune to witness was certainly of the highest scientific and technical attainment.

VIENNA.

INSTITUTE EXNER.

It is the merit of W. Exner in Vienna to have been the first who consolidated a group of engineers and physicians for the purpose of constructing prostheses and of standardizing the parts. He founded the association called "The Technique for War Wounded," and under its auspices an orthopaedic laboratory for the manufacture of prostheses is conducted. It was founded during the war in 1916.

In its present form the institution has become more or less independent of the big orthopaedic hospital in Vienna, which is directed by Spitzy. The institution is producing only a limited number of prostheses but the work is carried out with the utmost technical precision and the most accurate tests are constantly made as to the value of the materials and durability, and all technical details are thoroughly investigated. This institution is, therefore, not merely a workshop for the manufacture of prostheses but it is also a technical research station and the work is markedly superior to that seen in commercial shops.

THE VIENNA ORTHOPAEDIC HOSPITAL is under the direction of Prof. Hans Spitzy. It is housed in a new five story building, constructed during the war, and it is said that it contains four hundred patients, a larger number than any other orthopaedic institution on the continent. The operative side of the orthopaedic work is highly developed. The work shop excels especially in the manufacture of prostheses, a whole wing of the institution being given over to that work. The orthopaedic shop is under the medical supervision of Dr. Felix Bauer and through his courtesy the writer was able to become familiar with the details of the work.

THE CLINIC OF LORENZ has been considerably enlarged of late, the number of beds now amounting to about 40 or 50, including a barrack for children and a second barrack for the mechano-therapy of ambula-

tory patients. Dr. Julius Hass, who is first assistant, is a man of unusual attainments and a decided scientific bent, and the writer would not hesitate to count him as the best of the younger orthopaedic surgeons of Vienna.

A good deal of interest is being aroused by a new operation upon the femur called bifurcation, and applied in cases of old irreducible dislocated hips or in cases of non-united fractures. The method is essentially that of an oblique osteotomy, in which the point of the lower fragment is placed against the empty socket in such a manner that a sort of bifurcation results, with the head forming the upper, and the point of the neck the lower branch of the fork, the neck being implanted into the acetabulum.

From what I have seen and heard of patients who have had this operation performed, the functional results seem to be very good.

Of special interest is also the large collection of x-ray plates, especially those of bone degeneration and changes in general brought about by the low nutritional conditions. Numerous cases of hunger psathyrosis, and an endless number of severest types of rickets with spontaneous fractures or infractions of the bone are contained in the collection of Dr. Hass.

REPORT OF THE COMMISSION APPOINTED BY THE AMERICAN ORTHOPEDIC ASSOCIATION FOR THE STUDY OF STABILIZING OPERATIONS ON THE FOOT.

MAY, 1922.

To review briefly our work of last year: the Commission visited clinics prepared for them in the cities of Cleveland, Chicago, Milwaukee, Boston, New York, and Philadelphia; witnessed operations and personally examined the feet of some two hundred and fifty patients.

The Commission found that a flail foot—a foot in which the muscles were so completely paralyzed as to be unable to control the motions of the joints, an unserviceable foot, often painful, could be converted by certain surgical procedures resulting in ankylosis of the joints into a serviceable, painless foot: not a perfect foot perhaps, but a foot that the patient could use, one that he could depend on to carry him without discomfort through all the ordinary activities of his daily life.

Should the ankylosis take place with the foot in the position of even slight calcaneus the patient will be a heel walker and he will always limp. A heel walker, who bears little or no weight on the ball of the foot, will always limp, because the arc of the circle or rocker which the sole of the foot forms when in the act of walking over a flat surface is shorter on the side on which only the heel is used. This is equivalent to moving the fulcrum of the lever from two to three inches backward, thus displacing the center of gravity, shortening the time in which the foot rests on the ground, and causing an inequality in the gait.

The Commission holds that even this is a good operation because the patient is infinitely better off than he was before the operation. However, there is no good reason why the ankylosis should be allowed to take place while the foot is in the position of calcaneus, as it is perfectly practicable at the time of the operation to place the foot in the position of moderate equinus. The patient would then be able to use his whole foot, both heel and ball, in walking. This would give him a great advantage over the heel walker and would greatly diminish, if it did not entirely obviate, the limp. Furthermore, the raising of the heel would have the practical effect of lengthening, to a certain extent, the shortened leg and this would be an additional advantage.

Still even this, good as it undoubtedly is, is not the best result that can be attained.

An ankylosed foot is rigid and a rigid foot is not as serviceable as a foot with a limited amount of useful ankle motion.

A new and simplified ankle-joint can be made and the motions of this joint controlled by bone balance, independent of muscular action, by either the transverse horizontal section of Davis, in which no bone is removed, the open operation preferred by Hibbs and others, in which superfluous bone is removed, or astragalectomy after the method of Whitman, which consists of the removal of the astragalus and the displacement of the foot backward on the tibia and fibula. The result of the first two operations is an ankylosis of the tarsal bones and a displacement of the foot backward on what is left of the astragalus.

It is absolutely essential for the success of these operations that the foot be actually displaced backward and it is desirable that the foot be placed in the position of moderate equinus. In contrasting these operations, all of which, when properly performed on suitable subjects, give excellent results, the Commission prefers first, the astragalectomy of Whitman; second, the open operation advocated by Hibbs, and third, the transverse horizontal section of Davis.

In regard to the selection of cases, the Commission is convinced that patients having paralytic talipes calcaneus, talipes calcaneocavus, and flail or dangle foot, with or without the additional deformities of varus or valgus, are suitable subjects for the operations of astragalectomy and transverse horizontal section, and that patients having active calf muscles are *not* suitable subjects for these operations.

There is also a not uncommon class of cases which resemble equinus or cavus. These, however, have a rigid heel cord and on examination the astragalus and os calcis are found to be in nearly normal position, and the whole drop confined to the anterior portion of the foot. Should a foot of this type be mistaken for a case of talipes equinus and the heel cord subcutaneously divided, the result would be a surgical disaster, for the pseudo talipes equinus would be converted into a very real talipes calcaneocavus. The best method to remedy this deformity is to leave the heel and heel cord in their present position and to cut a sufficiently large wedge of bone from the dorsum of the foot to allow the anterior or dropped foot to be brought back to its proper position. The wedge of bone that has been removed contains the greater part of the head of the astragalus and the posterior articulating surface of the scaphoid, and the resulting ankylosis or union of these bones may be depended on to hold the foot in its proper position. The result is a stable foot, a little shortened, but with good ankle and lateral motion and under muscular control.

A wedge of bone with resulting ankylosis, or with the addition of more or less complete ankylosis of the bones of the tarsus, will correct such malformations or deformities of the bones as are commonly found in varus or valgus, or the same deformity may be corrected by removing superfluous portions of bone when the various joints of the tarsus are prepared separately for arthrodesis.

The Commission holds that although a faulty muscle balance was the first cause of the development of the deformity, yet the correction of a faulty bone balance must be the first step towards a cure.

The Commission fully realizes that none of these operations can be called curative in the sense that the case is definitely cured when the cast is removed and the wound healed. Unequal muscle balance will distort a growing foot and it is not always possible to predict with certainty the actual strength of a partially paralyzed muscle or transplanted tendon. Careless shoeing may also lead to disturbance of balance with consequent deformity.

All of these patients should be kept under occasional observation, if possible, until they have obtained their full growth.

It is important to maintain a muscle balance, and such tenotomies and tendon transplantations as may be obviously necessary can usually be done at the time the bone balance is corrected.

But, assuming that all of our patients' bones are of normal shape, what can be done with the muscles alone? Of the two hundred and fifty feet that the Commission examined last year, all, at one time, had bones of normal shape, the great majority had had tenotomies and tendon transplantations galore and yet all had come in the end to a bone-cutting stabilizing operation. The Commission naturally asked itself the question, is tendon transplantation really of any practical use except as supplementary to a bone-cutting stabilizing operation? Why not do, in the first place, the obvious practical thing that you will be ultimately forced to do?

But this is an unfair conclusion because we had seen only the cases that tendon transplantation had failed to relieve. Therefore, realizing that our report was still incomplete, the work this year of the Commission on Stabilizing Operations upon the Foot has been extended, by order of the President and the Executive Committee, to a study of the problem of partial and total paralysis of the dorsiflexors of the foot.

To this end clinics in Iowa City, Kansas City, Chicago, Cleveland, New York, and Hartford were visited by members of the Commission.

The problem presented this year to the Commission on Stabilization of Paralytic Feet, therefore, concerns the best method of treating the

drop-foot. By this, we understand, is meant the foot which has no power of dorsiflexion, and to which no such power can be supplied by tendon transplantation, and furthermore in which no tendency to lateral deviation or deformity exists. Several different methods of alleviating the condition have been considered in this study: 1—Arthrodesis of the ankle-joint by excision or by graft; 2—Silk ligament suspension; 3—Gallie's, Putti's, and Codivilla's methods of suspending the foot by fastening the tibialis anticus and peroneus tertius to the tibia; 4—The suspension of the foot by strips of fascia lata or the fascia of the leg; 5—The diamond-shaped excision of skin or bone flap from the front of the ankle and tarsus; 6—Astragalectomy; 7—By the use of braces or elastic bands.

1. Arthrodesis of the ankle-joint, by the usual method of excising the opposing articular surfaces of tibia, fibula, and astragalus. The operation usually fails to produce ankylosis if performed under the age of 14. It is advisable to fracture the external malleolus and displace it inward so that the three bones can be closely approximated, as otherwise the union is insecure. Most of the patients examined were dissatisfied with the result, although the feet were unquestionably stabilized. The chief complaint was of the increased strain thrown upon the medio-tarsal joint, and the difficulty in walking up hill and down hill, and in putting on and taking off the shoes. The latter difficulty is easily remedied by having the shoes laced down to the toes. The operation has fallen into disfavor, and is apparently very rarely performed in this country. The method originated by Lexer, of attempting arthrodesis by driving an autogenous or heterogenous peg up through the os calcis and astragalus into the tibia, is basically unsound, because the intra-articular portion of the peg usually becomes absorbed within a year, and the result is a failure. (Steindler is now bringing forward* a modification of Goldthwait's operation).

2. Silk ligament suspension, by passing heavy silk cords from the tarsus to the tibia, has been done in a fairly large number of cases. In very young children it is not to be advised, since, on the one hand, the silk is apt to cut through the bones of the tarsus, and, on the other hand, with the growth of the foot and leg the unyielding cords cause severe distortion and disability. In one case the foot was pointed upward at an angle of 25° from the horizontal, and it was necessary to lengthen the strong band of silk and surrounding tissue by operation. It is only fair to state, however, that in cases operated upon in early adult life the results are sometimes excellent: one patient was examined whose foot had been efficiently and satisfactorily held for

twelve years by silk ligaments. In some of the other cases the drop-foot had been controlled perfectly, but lateral distortion, either varus or valgus, had gradually occurred, as is seen so often after tendon transplantations and even after astragalectomy. In a few cases the silk had caused suppuration, sometimes months or years after operation. In the opinion of the Commission, the use of silk ligaments should be restricted to an occasional carefully selected case not under 15 years of age.

3. Tenodesis, or the fastening of tendons to the tibia (and fibula) by the method of Putti, Gallie, or Codivilla. This type of operation can be used in younger cases than the silk ligaments, since the attached tendons are likely to grow at approximately the same rate as the foot and leg. Gallie's technique has been carried out in a large number of cases, and while it has been successful in preventing lateral deformity and calcaneus in a very reasonable way, nevertheless, as a means of controlling drop-foot the results have by no means been universally satisfactory. In some instances, without a doubt, the technique has not been properly interpreted. The tendons must be carefully stripped and denuded, and even scarified, to ensure their adhesion to the bone; all strain and tension on the tendon must be neutralized; the time of immobilization must be long. And then, after union is complete, there is still considerable uncertainty as to whether or not the tendons, paralyzed and none too strong, will have sufficient strength to stand the continuous strain and drag of a lifetime of use. The Commission feels that there is a distinct field for this type of operation, and would have liked to see many more cases which had been operated upon years ago.

4. Suspension of the foot by strips of fascia lata or the fascia of the leg. Very few examples of this operation have been seen, and the results have not convinced us that it is to be advised. It is believed that strong strips of fascia lata could be successfully employed, in the same way that they have been used in reconstructing the lateral ligaments of the knee, but it is felt that sufficient time has not yet elapsed to demonstrate the permanency of the fascia lata.

5. The excision of diamond-shaped pieces of skin or a skin-bone flap made from the front of the ankle-joint, the incision being sutured so as to hold up the foot, is of temporary benefit only, since the remaining skin soon stretches and allows the foot again to drop, or the bone fractures, and then the skin stretches.

6. Astragalectomy.—This operation unquestionably limits the range of motion at the ankle, and although it was originally developed by Whitman to relieve the opposite condition (calcaneus or cavus), it

has a distinctly beneficial effect in drop-foot, especially where the foot is entirely flail. A few cases have been examined in which very free motion subsequently developed in the medio-tarsal and anterior joints, but the results as a rule have been sufficiently good to warrant its use in selected cases.

It will be seen, therefore, that the Commission does not feel convinced that any of the operative methods here considered can be confidently recommended as a standard procedure. We would further state that the lateral deformities of paralytic feet are far more disabling than drop-foot, and that they require operation in a far higher percentage of cases than does simple drop-foot.

7. It was found that several types of drop-foot braces were cheerfully and comfortably worn by both children and adults, whereas braces used to control the other varieties of foot deformities are not well tolerated. The plain elastic straps fastened to the shoe, the spring-wire supports with a coil at the sides of the heel, and the flat spring bent to fit under the sole and up the back of the leg are all useful and agreeable.

The Commission would urge that tendon-transplantation be almost universally supplemented by stabilization of enough of the smaller joints of the foot to prevent or correct all tendency to varus or valgus deformity, since the examination of a large number of post-operative cases has shown that the lateral deformities are of much greater importance than drop-foot.

(Signed)

Ansel G. Cook, M.D.,
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Current Orthopaedic Literature

TUBERCULOSIS.

TUBERCULOSIS IN CHILDREN FROM THE STANDPOINT OF THE SURGEON. Lloyd T Brown. *Boston Medical and Surgical Journal*, September 28, 1922.

This monograph discusses briefly the minor part which surgery plays in the eradication of non-pulmonary tuberculosis. Statistics and cases are presented as evidence of the advantages of rest and fixation.

Surgical immobilization alone of the spine is impossible. Supports should be used as long as the lesion is progressive. Recumbency is the best method of treatment. Surgical immobilization of the spine gives best results in adults if the operation is followed by recumbency for six months. Dr. Brown advocates recumbency for two or three years in the treatment of tuberculous caries of the spine.

The safe rule is—absolute fixation and constant immobilization of the spine in recumbency until resolution is established and the spine, with the aid of support, is capable of bearing weight without yielding. The period of recumbency must be determined by x-ray study and the general condition.—*William Jackson Merrill, M.D., Philadelphia, Pa.*

TUBERCULOSIS OF THE HIP. R. Franklin Buzby. *N. Y. Med. Jour. and Med. Record*, Aug. 2, 1922, p. 150.

A paper dealing with the pathology, symptoms, diagnosis, prognosis, and treatment of tuberculosis of the hip, special attention being paid to careful and long fixation of the joint. The generally accepted ideas of treatment are used.—*Edward S. Hatch, M.D., New Orleans.*

TUBERCULOSIS IN CHILDREN FROM THE STANDPOINT OF THE ORTHOPAEDIST. Joel E. Goldthwait. *Boston Medical and Surgical Journal*, September 28, 1922.

In the treatment of tuberculosis in children, Dr. Goldthwait lays special stress on the improvement of the child's general condition, proper posture, and correct use of the diaphragm, to increase the child's resistance to tuberculosis, as well as to other infections.

He advocates the prevention and correction of deformity during the course of, and after the subsidence of the disease, as indicated. He states, "as fast as the child is able to use the part, it is to be encouraged."

This is not safe in many cases, for many children will use the affected part when the course of the disease is progressive, before the diseased part is ready for functional stimulation, in which cases too early function prolongs the convalescence, increases the pathological area, and tends to produce greater deformity.

Frequent x-rays to determine the local progress of the disease, and the trend of the general condition must determine the time when function should commence.—*William Jackson Merrill, M.D., Philadelphia, Pa.*

DIFFERENTIAL DIAGNOSIS OF INCIPIENT TUBERCULOUS SPONDYLITIS AND CHRONIC RHEUMATISM OF THE BACK. P. Pitzen. *Munch. med. Woch.*, June 9, 1922.

Diagnosis of the beginning spondylitis is more difficult in adults than in children. The disease develops more slowly and the disturbance in the general condition is less. Loss of motion is less noticeable and the gibbosity appears later. Then also, other diseases cause pain in the back in adults, as, for instance, muscular rheumatism. Schede, Lange, and Eversbusch established that chronic muscular rheumatism causes "myogelosis." Pronounced hardness of the muscle, *i.e.*, "myogelosis," is sought for thus: The patient must be placed so that the musculature to be examined is relaxed. The examining fingers and the skin of the patient are greased. Then the muscles in the region of the pain are stroked crosswise to the direction of the muscle fibres, by the greased fingers, while the other hand fixes the muscle. The pressure must be firm enough to feel the muscle definitely. While healthy muscle is generally soft, the "myogelosis" feels like firm cords and painful on pressure. As a control, the same muscle on the other side can be examined likewise, or if that is diseased also, longitudinal strokes can be made on the diseased muscle. There then is felt at the same spot cords of different length which are differentiated by their consistency from the other muscular fibrils. If "myogelosis" is established, the diagnosis of chronic muscular rheumatism is almost certain but still spondylitis cannot be excluded, as there can be muscular hardness as a result of the strain of the musculature with tuberculosis of the vertebrae. With spondylitis, the pain is in the middle of the back or radiating to the trunk and extremities, and is influenced by the motions in the sagittal plane and is increased by tapping of the spinous processes of the diseased vertebrae or by jamming the vertebrae. With chronic muscular rheumatism, however, there is pain on one or both sides of the spinous processes in the musculature adjoining. Cautious motions and jamming of the vertebrae or tapping of the spinous processes have equally little effect. Motions of the vertebrae are completely lost in spondylitis, but limited with muscular rheumatism.—*Irmin Klein, Boston.*

OPERATIVE VERTEBRAL SYNOSTOSIS AS A TREATMENT FOR POTT'S DISEASE. Radulesco. *Revue d'Orthopedie*, July, 1922, p. 305.

In 1886 Wilkins attempted internal fixation of a tubercular spine by fastening the spinous processes together with metallic sutures. Hadra, in 1891, proposed tying the spine together with silver wire after forcibly correcting the kyphos as much as possible. This was tried by Chipault, but the wire cut through the bone and the deformity recurred. Vulpius, Lange, Clurch, and

Whitman, also proposed and tried various means of producing ankylosis of the spine. Albee, however, deserves great credit for developing a successful method for this purpose. Hibbs, Tuffier, Dujarier, Calvé and Galland have also devised methods which, except for that of Hibbs, are more or less similar to Albee's technique.

Radulesco describes a method which he has employed. He splits the spinous processes carefully into sagittal halves, after freeing them from each other by cutting the interspinous ligaments. These halves are then turned down laterally so that they lie flat, just like opening up a book, with the raw bone surface spread out. A graft is then removed from the rib, usually the eighth or ninth. This graft comprises only half the thickness of the rib, with spongy bone on one side and solid cortex on the other. It is placed flat on the prepared surface in the spine, spongy side next to the raw surface and is held in position by suturing the aponeurosis and muscles over it with strong catgut. For adults and older children he uses spinal anesthesia because the patient can lie quietly in the ventral position after the operation without the disturbance which follows general anesthesia. This ventral position is maintained for six or seven weeks, then the patient is turned on his back for a month longer. Most of the patients leave the hospital without any supporting apparatus.

In judging the value of the open operation there are many factors to be considered. The author's cases were almost all done at a seaside sanatorium where conditions were much more propitious than in the large cities. The method of operating and the skill of the surgeon influence the results. Of 250 cases done by Albee there was no mortality, while among 288 operations by various surgeons there occurred 12 deaths. Vulpius reports 30 cases with excellent results in all. Hans Thomsen published 17 cases with four deaths and poor results in the others. Clairmont obtained a cure of paresthesia in a man of 20 by the Albee method. Many other authors are cited with various results, but on the whole favorable to the ankylosing operation. Almost all these observations are by continental surgeons. It is the opinion of many of them that the operation is not a substitute for the classical methods of treatment but only an adjuvant procedure. Calvé regards it as contraindicated in young children.

As to methods, the author has rejected the Albee technique because it is more difficult than others, because the tibial graft has to be cut and bent to fit the kyphos, thereby causing weakness, and because the spinous processes are too narrow to furnish a good grafting surface by this method. The Hibbs operation is ingenious in appearance, but most surgeons get bad results with it. The procedure of Calvé and Galland, which involves resection of the entire spinous processes and arthrodesis of the intervertebral joints, while logical, is too complicated and attended by too much shock. By his own method Radulesco claims to obtain a larger and more solid callus than by other methods. Also, the graft from a rib is always curved to fit the kyphos and is easily bent; it leaves practically no defect in the rib and is more accessible than the tibia. Twenty-five cases have been treated by him and his associates according to this method. Most of the cases chosen for operation had abscesses, paraplegia or tubercular lesion of other organs. These were chosen designedly to test the value of the method. Some who had been in bed months, or even years, recovered movement and were able to walk without support in two or three months after

the operation. The results in general have been good and no deaths occurred. One patient developed tubercular peritonitis four months after leaving the hospital, one had a cold abscess and sinus form at the site of operation without elimination of the graft. In another case the graft came out because of suppuration, but a callus formed, nevertheless, and the result was as good as the other cases. *William Arthur Clark, Pasadena.*

CONGENITAL DEFECTS AND CONGENITAL DISLOCATIONS.

LATE RESULTS OF MANIPULATIVE TREATMENT OF CONGENITAL DISLOCATIONS OF HIP. E. L. Evans. *Brit. Journ. of Surgery*, July, 1922.

Evans' personal experience relates to 49 cases of congenital dislocation of the hip, involving 61 joints, treated between the years 1903 and 1916 inclusive. Of these he is enabled to give the late results in 31 cases, involving 38 joints.

He groups his results as follows:

Groups.	No. of cases.	Percent.	Average age.
1. Concentric reduction with normal head and neck	10.	26.	4.1
2. Concentric reduction with changes in head and neck	13.	34.	5.1
3. Excentric nearthrosis	5.	13.	4.5
4. Anterior transpositions	4.	10.5	4.8
5. Posterior dislocations	1.	2.5	6.5
6. Loss of head and neck	1.	2.5	2.9
7. Unreduced dislocations	4.	10.5	6.75
Total cases	38.		

X-ray illustrations of the results are given and show the usual deformities of head and neck to be encountered in such a series as we see them in America. He has had one loss of a head and one fracture. The method of reduction was based upon Lorenz's manipulation, though with increasing gentleness with increased experience. The limbs were put up in plaster flexed 90 degrees and abducted 70 degrees, the double cases kept up from three to six months, the single ones from eighteen months to two years. *Charles A. Parker, Chicago.*

LATE RESULTS OF TREATMENT OF CONGENITAL DISLOCATIONS OF HIP. H. A. T. Fairbank. *Brit. Jour of Surgery*, July, 1922.

Fairbank bases his conclusions upon 146 personal cases in which 175 hips were treated.

He follows the Lorenz method of reduction, though avoiding the rougher means that Lorenz originally used. Thirteen cases were treated by the open method and the results shown in a separate grouping.

His late results are given in 112 cases that were followed for at least five years.

The following table records his results:

Unilateral

Age	cures, percent.	Anterior repositions, per cent.
Under 3 years	70.	15.
3, 4, 5 years	40.9	27.2
6 and over	28.5	33.3
All ages	46.	25.3

Bilateral

Age	cures, percent.	Anterior repositions, per cent.
Under 3 years	46.6	33.3
3, 4, 5 years	22.7	18.
6 and over	33.3	25.
All ages	32.6	24.4

He commences treatment as early as 18 months in the absence of indications for delay. His oldest patient was 14 years, an unsuccessful case.

Among the complications there were five fractures. Changes resembling osteochondritis deformans juvenilis occurred in 7 cases. Arthritis with stiffness of the hips developed in six cases under treatment, the symptoms varying in duration from a few weeks to 18 months, but in every case subsiding with rest. One hip ankylosed through infection from suppurative hæmatomas in the adductors.

Of the 13 operated cases no late results could be obtained, although all but two were reduced by the operator. A third hip was so unstable after reduction that an attempt at cure was abandoned and in one case infection occurred with ankylosis in position above the acetabulum.

His deductions are as follows:

1. If treated sufficiently early an anatomical cure by manipulation should be obtained in 75 per cent. of the unilateral and 50 per cent. in the bilateral cases.

2. Additional attempts should be made in the unsuccessful cases followed in two or three weeks by an open operation whose purpose is to make an upper lip to the acetabulum without opening the joint, a comparatively safe procedure, he considers.

3. Open reduction should be used only in refractory cases in infants and in selected cases over 6 years of age.

4. Full right angled abduction should be maintained for a minimum of six months.

5. He hesitates to attribute to the anterior repositions any advantage over untreated cases as far as late results with arthritis are concerned.

6. Physical treatment after removal of cast probably has no effect on anatomical results.—*Charles A. Parker, Chicago.*

Some Considerations on Dorsalization of the Seventh Cervical Vertebra.

Fouilloud-Buyat. *Revue d'Orthopedie*, July, 1922. Page 333.

The author reports, as follows, a case of cervical ribs:

Woman of 25 developed pain and swelling in the right arm and formication in the right hand without obvious cause. These symptoms were exaggerated if the arm hung down or if she carried anything heavy. Fingers were somewhat swollen but cold. Medication was of no avail and the pain steadily increased, radiating to the base of the neck and the occipital region. A diagnosis of cervical Pott's disease was made and a cast applied, but without relief. Seven months after the onset of the pain in right arm the same set of symptoms developed in the left arm.

Examination showed normal movements in the cervical spine, but tenderness on pressure over the third to seventh cervical ribs. 'Tenderness also on pressure about 2 cm. behind the clavicle, but nothing objective found there. The muscles of the shoulders and arms were slightly tender. Otherwise the examination was negative. The possibility of Pott's disease was rejected and a diagnosis of cervical ribs was made and confirmed by roentgenogram. They were bilateral with head, neck and tuberosity similar to normal ribs. The transverse processes of the seventh cervical were enlarged.

Surgical treatment was refused and the patient's condition remains about the same.

In the symptom-complex produced by cervical ribs the nervous phenomena usually predominate. Bilateral pain is very rare, even in cases of evident bilateral lesions. Vedova reported 14 cases with the malformation on both sides, but symptoms only on one side. In the above case the anomaly comprised two elements: the cervical ribs and the hypertrophied transverse processes of the seventh cervical. These processes were not only unusually large, but were directed upward more than normally. This part of the deformity may exist independently. A case is cited in which the symptoms were typical of cervical rib, but only an enlarged transverse process was found by roentgenogram. In these cases the seventh cervical conforms more to the dorsal type than to the cervical.

We are by no means certain regarding the mechanism which produces the symptoms in these anomalies. Some cases are completely cured by removal of the supernumerary rib, others are only improved temporarily, others are not relieved at all. Why this difference in results? Are the symptoms due to compression or must we look for some other explanation? Oppenheim has said that there may be a malformation of the soft parts of the spinal cord coverings concomitant with the bony malformation, just as is encountered in spina bifida. It seems logical to admit that instead of a cervical rib producing a dystrophic influence on the spinal cord, a malformation of the medullary structures, itself of little importance, manifests itself objectively in a developmental trouble of the vertebra. Symptoms such as tachycardia, hoarseness, and ocular troubles seem easily explained by pressure on the cervical sympathetic ganglion, but may they not have their origin higher up where these sympathetic filaments

come out from the cord? These ideas should not be regarded as hypothetic, because cases of syringomyelia have been reported in which the symptoms were very similar to those of cervical ribs, but in which, of course, no bone lesion or abnormality was present.—*William Arthur Clark, Pasadena.*

SCAPULA CRACKLING SOUNDS. O. Heinemann. *Klin. Woch.*, April 15, 1922.

Author reports case of patient of twenty years with crackling sounds, unaccompanied by pain, on motions of the left arm in the horizontal plane above the shoulder level. He removed a round exostosis, the size of a pea, subperiosteally from the upper, inner angle of the scapula. There was a permanent disappearance of the noise, while function of the arm was unaffected. This exostosis is described by anatomists as the inconstant tubercle of Luschka. Why the quite frequent Luschka's tubercle causes scapula crackling sounds only in exceptional cases needs further explanation.—*Armin Klein, Boston.*

PAIN DUE TO OS TIBIALE EXTERNUS. S. Peltesohn. *Klin. Woch.*, April 15, 1922.

In the adolescent foot as a rule in the early twenties there occur painful occasions which are connected with the presence of the inconstant external os tibiale. When one finds in a young pes valgus (not planus) a strong spring of the navicular bone, which on pressure or spontaneously is painful, and if a foot distortion preceded, then there is apparently an external os tibiale present, and it can be diagnosed with almost a certainty, even before roentgen examination. These cases usually occur in young girls of strikingly large, slender joints, with a marked prominence of the navicular tuberosity. The removal of the pain with the external os tibiale is to be attained in newer cases by "supinating adhesive plaster bandages and individually built plates." In older cases the plates usually cure. Their fitting should be personally and thoroughly carried out by the orthopaedic surgeon. It is quite possible that the external os tibale disposes to the pes valgus during the years of growth.—*Armin Klein, Boston.*

THE PRODUCTION OF TEMPORARY PARALYSIS IN THE TREATMENT OF DIFFICULT CASES OF CONGENITAL DISLOCATION OF THE HIP-JOINT. George Robertson. *Surg., Gyn., and Obstet.*, August, 1922.

In cases from five to seven years and over that age much difficulty may be encountered. To minimize this muscular difficulty author recommends that temporary paralysis of great adductor group be produced by ligature pressure of trunk of obturator nerve by open operation. Incision same as made for femoral hernia. Accessory obturator nerve when present may be divided at the same time "with medium pressure upon nerve by direct ligature and maintained from one and one-half to two hours will give a paralysis of six months' duration." Special method of applying the ligature to allow of its easy removal after skin has been sutured is described by author in drawings. Author considers this method in certain difficult and rather late cases. He also uses this same procedure of nerve ligature for securing good alignment in fracture of the long bones.—*Thomas Madden Foley, Washington, D. C.*

Bony Features of Posterior Congenital Dislocation of the Shoulder. T. Wingate Todd. *Annals of Surgery*, July, 1922, p. 70.

This article is based upon a study of 730 skeletons. It is not a true dislocation, but rather an imperfect development of the posterior border of the glenoid. The humerus is still in contact with the glenoid. The head of the humerus is normal. The acromion process is slightly depressed. The clavicle and coracoid are normal.

There were three cases found in 730 skeletons. All occurred in white males.

There is nothing to indicate that this in any way interfered with the function of the joint. References are appended.—*F. G. Hodgson, Atlanta, Ga.*

FORMS OF ARTHRITIS.

Osteoarthritis: Principles Underlying Its Surgical Treatment. A. G. T. Fisher. *Brit. Journ. of Surgery*, July, 1922.

The following footnote on the title page suggests the high character and extensive scope of this contribution:

"Embodying the Hunterian lecture delivered at the Royal College of Surgeons of England, and constituting an abstract of a preliminary report to the Medical Research Council, who have generously defrayed the expenses of the research."

The author has undertaken a very ambitious work embodying a study of the etiology, pathology, symptoms, and treatment of this veritable orthopædic scourge. It brings to mind the monumental work of Nichols and Richardson, of Boston, in 1910, although it is not so extensive.

Regarding the nutrition of the joint cartilage and its relation to osteoarthritis, he distinguishes the central or free surface of cartilage and the lateral or portion next to the synovial membrane, and of the two thus speaks: "At the edge the articular cartilage becomes markedly fibrillated, and merges into the fibrous tissue, beyond which it is furnished with capillaries, derived from the circulus, without there being any marked increase of cellularity accompanying the transition. In the thin synovial layer over the lateral articulating area lie capillaries derived from the circulus articuli vasculosus of William Hunter. This lateral part is therefore far better nourished than the central. This fact is of fundamental importance and, in my opinion, is the key to many of the phenomena of osteoarthritis; for my theory, as will be seen later, is that the central part of the articular cartilage responds to the cause of osteoarthritis by degeneration, whereas the lateral part proliferates, owing to its richer blood supply." Thus the burden of his story is that the central portion of the articular cartilage degenerates at the same time, or rather preceding the time of the proliferation of the marginal portion with its developing "chondro-osteophytes."

An increased vascularity is considered the regular picture in the active stage of the affection and arteriosclerotic changes are of late appearance and are not considered of etiologic importance.

He thus defines the condition: "Osteoarthritis does not constitute a disease *sui generis*, but rather the series of physiological or pathological changes that occur in a joint when it is subjected to prolonged or oft-repeated injury either mechanical or toxic, but of a moderate degree of intensity." As to bacterial or other toxic products he inclines to the view that they are mostly transported to the joints from distant infectious foci. Outside of various traumata, he blames the toxins for most of the trouble.

As a basis of treatment he italicizes the following:

"(1) Eradication, as far as possible, of any focus or foci of toxic absorption, including measures that prevent the formation or assist the elimination of systemic toxins. (2) The cessation, particularly in uni-articular cases and in the lower extremity, of pressure between diseased articular surfaces. (3) Local treatment to the joints themselves to stimulate defensive reaction of articular elements, and to prevent ankylosis. (4) Dietetic and medicinal treatment."

He recommends the usual measures to clean up foci of toxic absorption, and suggests plaster casts for relief of acute conditions of joints and the use of caliper splints to protect joints of the lower extremity. Early eradication of sources of toxins is stressed. He advises the surgical measures usually employed to overcome deformities and to obtain better positions for the partially or wholly ankylosed joints. Regarding diet he says: "Sufferers from osteoarthritis are so apt to lose weight from the constant exhausting pain, that it seems desirable that the diet should be generous, strengthening, and digestible, and yet not of such a nature as to favor intestinal putrefaction. He is not enthusiastic about medicine in the treatment.—*Charles A. Parker, Chicago.*

Dietetic Treatment of Chronic Arthritis and Its Relationship to the Sugar Tolerance. A. Almon Fletcher, M.B. *Archives of Int. Med.*, July, 1922.

Fletcher presents a study of one hundred cases of arthritis in which the sugar tolerance was determined and in which the effect of reduction of diet alone was studied. The majority of patients were of the peri-articular type, with and without deformity. A few showed hypertrophic changes, and one or two showed both types. The study of these patients was well conducted and well controlled.

The sugar tolerance test of Hamman and Hirschman was used. The striking characteristic in the figures presented is the height, that is: lowered sugar tolerance, which many reached, and especially the delay in the return to normal. Three groups were selected—(1) those in which the average was less than 1.4; (2) those in which the average was from 1.4 to 2; and (3) those in which the average was greater than 2.

Many interesting points were brought out, a few of which might be mentioned. No relationship was found of the sugar tolerance to the severity of the disease. Women were found to have a lower tolerance than men. No sugar was found in the urine during the test.

The point was brought out also that the response to the reduction of diet in an arthritic is roughly proportionate to the reduction of the sugar tolerance, although there were occasional departures from this rule.

It would seem as though there were some evidence to suggest that a disturbance of the sugar tolerance is associated with infections. When various low

diets were being tried it was found that reduction of carbohydrates alone did not yield the best results, and the diet finally chosen was one low in calories but rich in vitamin contents. The author was of the opinion that the results of this diet appeared favorable enough to suggest the existence of an actual vitamin deficiency in arthritics. It was found, however, that the addition of the vitamins to the high calorie diet did not act as well as to a low calorie diet. The author feels that the reduction of protein in arthritics may do positive harm. His conclusions are as follows:

1. Of one hundred cases of chronic arthritis, reduction of diet alone appeared to result in the recovery of eight patients and in quite evident improvement in forty-three.

2. The sugar tolerance was decreased in the large majority of cases, and this decrease showed no relationship to the severity of the disease.

3. Patients who have a low tolerance are much more frequently benefited by reduction in diet than those cases with normal tolerance.

4. In certain cases of chronic arthritis, dietetic regulation appears to be the most effective form of treatment, and while the value of such treatment in an individual case cannot be determined with certainty, the lowering of the sugar tolerance is a useful clinical indication for this procedure.

5. Female patients derive greater benefit from such treatment than men, and, as a rule, they show a lower tolerance.—*M. S. Henderson, Rochester, Minn.*

OSTEOARTHRITIS OF THE HIP. George Parker. *British Medical Journal*, Sept. 23, 1922, p. 539.

A table of joint diseases prefaces this article, in which Group A is characterized by diseases showing little or no affection of the fibrous or synovial structures, but great bone and cartilaginous changes, as exemplified by osteoarthritis and gout. In the B groups septic causes are acknowledged. In B1 we find suppuration, as septic and tuberculous joints, in B2 there is no suppuration, but fibrous overgrowth and ankylosis, as exemplified by rheumatoid arthritis and gonococcal joints. B3, the last group in the writer's classification, leaves no permanent joint changes, as in true rheumatism.

The writer insists on the tendency of osteoarthritis of the hip to be essentially monarticular and of a distinctive character, though he admits that some authors disagree with him, considering that it may follow or precede similar changes in other joints. The symptoms are given in great detail: pain, tenderness, pseudo-locking attitude, muscular wasting, grating, and x-ray changes. Sometimes the hip presents the exact picture of an impacted fracture of the neck of the femur. It is noted that lameness and limited movement may exist long before bone changes are shown in the x rays. Pathological changes are thinning of the cartilage at the centre of the joint, thickening at the periphery, with new bone formation and eburnation.

As regards etiology, J. Llewellyn is quoted as pointing out the influence of trauma to the hip. This may be acute, or may be chronic, due to knock-knee, flat-foot or a short leg. Mr. Strangeways, of the Cambridge Research Hospital, considers that thickening of the vessel walls may bring about changes in the

nutritive value of the synovial fluid, which under normal circumstances, he holds, is a source of nourishment to the articular cartilage. Altered nutritive value in this fluid leads to cartilaginous degeneration and fibrillation. There is no evidence of neural origin of the disease, and very little in favor of an endocrine source, though osteoarthritic changes occur in acromegaly. P. W. Nathan, with others, is quoted in favor of an infective origin, streptococci being lodged in the neighborhood of joints whose circulation is least active.

Treatment: Remedy any obesity, flat-foot, etc., capable of causing joint strain. Limit the exercise taken. Very early cases have a good chance of complete cure by absolute rest, the hip immobilized and no weight-bearing permitted. Such cases must be differentiated from gout and sciatica. There is not the same tendency to ankylosis which exists in rheumatoid arthritis, and which makes immobilization so dangerous in this latter condition. More advanced cases need leather spicas, radiant heat, and massage. Pain is relieved by ionization with salicylates and iodides, hot sand bags, and the inunction of salicylic acid and menthol. Arsenic and thymus gland are advocated internally. Removal of the head of the femur has given good results, the neck articulating in the acetabulum, while ankylosing the joint gives relief from pain at the expense of movement.—*J. A. Nutter, Montreal.*

CHRONIC INFLAMMATION OF THE KNEE JOINT AFTER INJURIES. Rost. *Klin. Woch.*, April 15, 1922.

The author is concerned with the slight chronic knee joint inflammation, often preceded by a very insignificant trauma, as a strain, or even where there has been no recognized trauma, and an extravasation of blood into the joint never existed. Author recalls Hoffa's work in 1904 on sclerosis of the anterior fatty body of the knee joint which followed slight trauma. Hoffa found that the anterior fat body placed under the quadriceps tendon became prominent, felt firm, often was pseudo-fluctuant, and was more or less painful. He removed the body. Other surgeons did likewise but their results were not as good as Hoffa's, and the subject was forgotten. Author believes there is a germ of importance in Hoffa's work. Anatomically the three fatty bodies are under the quadriceps tendon, in the popliteal space and on the femur extending to the border of the cartilaginous surface of the joint. Experimentally, author proved that inflammatory changes in the posterior fatty body inhibited extension and in the anterior body inhibited flexion. With joint inflammation after the injury the author could show, as in animal experimentation, that a circumscribed pathologic change may take place in the anterior fatty body when the neighboring synovial membrane histologically is absolutely normal. Author states that he could show exactly as with animal experimentation that in joint inflammation, post-traumatic, a circumscribed pathologic condition appears, particularly in the anterior fatty body, while its neighboring synovial membrane is completely normal. With regard to the origin of chronic knee joint inflammation with slight injuries, he places great value on the normal wearing away of the knee joint. The fact is that in a surprisingly large number of normal knee joints one finds spots where the cartilage has softened or degenerates. He

quotes statistics showing that only in 65% of cadavers of twenty to forty years is there no such cartilage degeneration. In corpses over forty years, 95% have the condition demonstrable. These areas become roughened and rub on the synovial membrane and irritate it. The injury to the knee joint here is from within out, as it were. These areas of degeneration are found mostly on the patella. Histologically they resemble arthritis deformans, but the process is circumscribed, while in a true arthritis deformans the whole joint is affected. He does not believe this degeneration to be an early stage of arthritis deformans, for if it were, every elderly person would have arthritis deformans. It is, of course, possible that arthritis deformans may develop from such a degeneration. As to the therapy: He advises rest for the early cases and then forceful massage. Hot air treatments are very acceptable, but author is not convinced of any special benefit from them. Large joint effusions have to be punctured. Extirpation of the fatty body is only to be done when complaints are severe and conservative treatment unavailing.—*Armin Klein, Boston.*

SCOLIOSIS.

Gradual Correction of Scoliosis in Segmented Plaster Jacket. J. Hanausek. *Revue d'Orthopédie.* March, 1922.

This article appears under the title, *Contribution au traitement de la scoliose par les corsets plâtrés*, and is an interesting presentation of the author's method. For a complete understanding one should refer to the original article for sketches of the comparatively simple mechanical appliances required. Procedure is based on the argument that force applied laterally to the prominent ribs increases rather than corrects the deformities, and that rotatory corrective forces alone are logical. Patient stands on the intersection of two folding cross-arms, from each end of which rises a stout upright. Traction bands are secured to these uprights; two bands, passed about upper thighs in opposite directions, hold the pelvis rotated in correct direction; a third band, pressing against the prominent ribs posteriorly, tends to rotate the trunk upon the pelvis. Details as to padding follow; removable pads are placed over parts to be rendered more prominent, as correction, and later over-correction, is obtained. Jacket is then applied, and several days later, while still on patient, it is sawn at the waist into two segments. These segments are made to rotate, the one on the other, by means of a stout hinge of special design, fixed at one side of the spine. Eyelets are also fixed to the segments, by which means padded levers can be attached for purpose of corrective rotation. Progressive, daily correction is made, and is maintained by means of bands hooked into the eyelets and half-encircling the trunk. Photographs are shown of a patient with a marked degree of rotary lateral deformity before treatment, and again eight months after treatment; the amount of correction, both as to curvature and rotation, is striking. After a certain period of progressive correction the author's method includes the use of a celluloid jacket, modelled after an ingenious plan to represent the maximum degree of correction obtained, and the practice of physiotherapeutic

exercises, etc. If necessary, the two processes are repeated. His method differs from Abbott's in that he uses the upright position for application of cast, arguing that unless correction is made against the maximum obstacles the final gain will be less. A review of this article gives one the impression that this method, as practised by the author, is distinctly worth an extensive trial.—*Roades Fayerweather, M.D., Baltimore, Md.*

Is There an Operative Treatment of Scoliosis? H. Hoessly. *Zeit. f. Orth. Chir.*, 1921, xli, 3 H., p. 193.

The author believes that operative treatment is justifiable in the paralytic and severe rachitic cases. The operation is planned, not at the height of the curve on the convex side, but at the point of greatest convexity, and is in the nature of bone transplantation. The results in three cases, after a lapse of one and a half to two years, showed straighter backs, with strong mechanical supports. The author suggests an approach through an abdominal incision in operations upon the lumbar vertebrae, especially where developmental anomalies are present.—*Roland Hammond, M.D., Providence, R. I.*

Operative Treatment of Scoliosis. S. Kleinberg. *N. Y. Med. Jour. and Med. Record*, July 19, 1922, p. 93.

The author feels that 60 to 70 per cent. of scoliosis cases can be improved by corrective jackets worn for a long period of time, and that by putting these patients in hyperextension on a frame with traction at the head and pelvis a maximum amount of reduction is obtained in 8 weeks.

On removing these patients from the frame the deformity recurs and the author is doing a fusion operation on a single curve, which is a combination of the Hibbs and Albee technique, combined with a beef bone graft about 8 inches long.

This is followed by recumbency without the frame for 10 days, then the frame and traction for 8 weeks, followed by a plaster jacket or brace for 3 to 6 months.

So far the results have been good.—*Edward S. Hatch, M.D., New Orleans.*

OSTEOMYELITIS.

Bone Diseases: Non-Suppurating Osteomyelitis (*Garré*); Infectious Ossifying Periostitis (*Bloodgood*). Joseph C. Bloodgood, M. D. *Journal of Radiology*, Aug., 1922.

Bloodgood refers to infectious ossifying periostitis in this article. The first case he reports is a patient who, eight years before, had a diagnosis of sarcoma made of the upper end of the femur, and amputation advised. He had refused

the operation and sought advice elsewhere, and finally conservative measures were carried out. He is alive and well today, and the condition less prominent than at that time. This one case emphasizes particularly the fact that diagnosis of sarcoma has probably often been made in this condition and limbs sacrificed.

The cases he mentions evidently belong to the group described by Dr. S. Fosdick Jones, in the *Journal of the American Medical Association*, September 21, 1921, who credited Garré with establishing the entity.

He reports a rare case involving the hip-joint and upper end of the femur, and gives as the etiological factor gonorrhea.

He also mentions another case involving the upper end of the femur, but not the hip-joint, in which the etiology was considered as being due to an abscessed tooth.

In the differential diagnosis he stresses the point that the medullary cavity is more readily to be outlined in the x-ray than is the case when the condition is sarcoma.

The author reports in this article two cases that he considers to be multiple infectious ossifying periostitis, and one in which the bones of the skull were involved.

His conclusions are as follows:

1. Apparently there is a definite type of non-suppurating ossifying periostitis of sclerosing osteomyelitis. I have sufficient cases to demonstrate that trauma and syphilis may produce it. It is observed as a post typhoid and post-influenza lesion, and apparently it may be secondary to any type of infection.

2. The most important points in treatment are the administration of salvarsan intravenously and a search for the focus of infection, which, when found, should be removed. I have no evidence as yet that incision with removal of the new bone formation is helpful.—*M. S. Henderson, Rochester, Minn.*

Transplantation of Entire Fibula in Cases of Loss of Tibia from Osteomyelitis. W. Russell MacAusland and A. F. Sargent. *Annals of Surgery*, July, 1922, p. 1.

The value of this transplantation as compared with tibial graft consists in:

(1) Less danger of infection, on account of small exposure in healthy tissues.

(2) Blood supply of fibula is not disturbed, so it does not die.

(3) The transplant rapidly hypertrophies to take care of added weight and leaves no defect from absence of fibula.

(4) Fracture of graft does not occur.

The entire transplant of fibula is only used in cases where there is a large defect in the tibia and disability is complete.

The lower and upper epiphyses of tibia are usually not destroyed in osteomyelitis of tibia.

The technique is described:

He first transplants the severed upper end of the fibula into a cup-shaped depression made in the end of the head of the tibia. The periosteum of fibula is left attached to both the head of fibula and the transplant. This often forms

a bony bridge and gives additional support to the upper end of bone. No non-absorbable material is used. The leg is put up in a plaster cast from toes to mid thigh and left for two months.

Then the lower end of the fibula is similarly severed and put into lower end of tibia. After two months, weight bearing is allowed with the leg in a plaster cast, or a caliper splint.

Four cases are reported. The literature of the subject is reviewed. The article is illustrated by good drawings of the operation, and a number of very interesting x-ray plates showing the results of operation and the marked hypertrophy of the fibula after use.—*F. G. Hodgson, M.D., Atlanta, Ga.*

CONTRIBUTION TO STUDY OF OSTEOMYELITIS OF THE RIB. A CASE COMPLICATING CHICKEN-POX. P. Philardeau. *Revue d'Orthopédie*, May, 1922.

The rib is not often involved in any type of osteomyelitis, and the author has been unable to find a single case reported as developing in the course of chicken-pox. The lesion in his case was in the anterior portion of the left 10th rib. Recovery followed a partial resection and drainage. Organism isolated was identified as the *enterococcus* (see note*); said to be a very rare causal factor in osteomyelitis. Author takes occasion to discuss the anatomical development of the rib, with relation to site of infection at different ages.—*Roades Fayerweather, M.D., Baltimore, Md.*

*Note: In English terminology, *micrococcus ovalis*, or *streptococcus gracilis*.

ANALYSIS OF 160 CASES OF OSTEOMYELITIS WITH END-RESULTS. J. S. Speed. *Southern Med. Jour.*, Sept., 1922.

This series includes only hematogenous infections, 29 localized and 131 diffuse types. Of the diffuse cases 70% were between 8 and 14 years of age: 40% tibia, 35% femur, 7% humerus, 7% radius and ulna and 2% fibula. In 16% two or more bones were involved. Positive x-ray findings usually appear from two to ten days after onset of acute symptoms, so that a negative radiogram during the first ten days does not exclude bone disease. In some cases this applies to even a longer period. Pictures must show clear detail and even then a sequestrum often fails to show clearly in chronic eburnated bone.

Twenty-one patients were in the acute stage, of whom seven died. Trap-door drainage was employed. In three of ten cases traced no further operation was required for cure. He does not say how soon after onset these were drained.

In the chronic cases the usual procedure of removing sequestra, thorough exploration of neighboring medulla and conversion of cavities and tunnels into saucer-shaped basins, was employed. In acute cases the clean-up operation is postponed until there is sufficient new bone laid down to preserve continuity. Nothing is said of Dakin's solution or other special postoperative care of wounds. Possibly the author considers, and rightly so, that this makes little difference if the operation is thoroughly and properly done.—*R. W. Billington, Nashville.*

THE VALUE OF DAKIN'S SOLUTION IN THE TREATMENT OF ACUTE AND CHRONIC OSTEOMYELITIS. A. O. Wilensky, M.D. *Annals of Surgery*, June, 1922, p. 708.

Only cases of osteomyelitis due to the common pyogenic organisms are considered.

The pathology of acute and chronic osteomyelitis is quite clearly outlined.

The factors which determine the efficiency and success of the Carrel-Dakin treatment are: (1) The removal of all sources from which continuing or repeated reinfections can take place; (2) Complete asepsis in the dressing; (3) Rigid attention to details; (4) Chemically correct solutions; (5) Intimate contact between the infected surfaces and areas and the antiseptic solution.

Each of these headings is discussed.

On account of the difficulty in carrying out all of the conditions the author concludes that very few cases are really suitable for the carrying out of this method. If a radical operation is performed and the wound suitably prepared for the use of this method, it is found that many cases will heal by granulation and strapping the wound edges together just as promptly as if the Carrel-Dakin method had been used.

Wound healing may occur by either method, but relapses are very prone to occur.—*F. G. Hodgson, Atlanta.*

FRACTURES AND DISLOCATIONS.

SPIRAL FRACTURES OF THE TIBIA AND FIBULA. John A. Caldwell. *Annals of Surgery*, June, 1922, p. 717.

The spiral fracture is caused by a twist of the leg with the foot fixed, while carrying the body weight. Usually the tibia is fractured in the lower third and the fibula in the upper third. The author says it is impossible to reduce this fracture by traction, and even with open operation it is very difficult to reduce. He concludes that all cases unoperated result in some deformity and prolonged disability; so he advises operation in all cases.

Four methods are available: (1) plating; (2) intramedullary dowel; (3) bone screws and (4) banding. He prefers the last method, using the Parham Martin band. He waits ten days before operating. He describes his technique and advises removal of the band in two to three months. He reports ten cases. There were two surgical infections.—*F. G. Hodgson, Atlanta, Ga.*

FRACTURE OF THE CAPITELLUM AND TROCHLEA. Martin C. Linder. *Annals of Surgery*, July, 1922, p. 78.

This is an uncommon fracture. Seventeen cases found in literature. The lesion is a splitting off of the articular surfaces of the lower end of the humerus with a thin strip of cancellous bone. It is an *intracapsular* fracture and the fragment lies free in the capsule, usually in the front of the humerus, but it may be posterior. It is caused by a fall or a blow on the flexed forearm. The

chief clinical features are: (1) Spontaneous pain in the region of the fracture, not dependent upon motion: (2) No change in the normal landmarks of the elbow; (3) Progressive limitation of the motions of the elbow-joint to fifteen degrees; (4) Finding on palpation of a bony projection in the ante-cubital fossa; (5) Crepitus caused by loose body in the joint.

The x-ray picture is quite characteristic and makes the diagnosis definite. The best treatment is excision of the fragment. Reposition has been tried but callus formation blocks the motion of the joint.

Three cases are reported, with good x-ray plates.

References to the literature are added.—*F. G. Hodgson, Atlanta, Ga.*

Recurrent Dislocation of the Patella. W. R. MacAusland and A. F. Sargent. *Surg., Gyn. and Obstet.*, July, 1922.

The etiology of the condition is discussed very fully, injury and excessive knock-knee being the chief factors. Among contributory factors are considered heredity, muscular weakness, flat-feet, elongated patellar tendon, imperfect development of the patella, imperfect development of the external condyle of the femur.

The initial attack is most painful, and is usually followed by acute synovitis of the knee-joint.

Treatment of the acute attack calls for three weeks of plaster immobilization.

Recurrent attacks may be treated from four viewpoints:

1. Support:—By pad or knee-brace.
2. Stimulation:—By baking, massage, exercises.
3. Correction of static errors:—*e.g.*, Whitman plate for flat-feet.
4. Operation.

Of operative methods, capsulorrhaphy alone is a failure. Transplantation of part of the patellar tendon was employed in some of the earlier cases, but was considered less satisfactory than transplantation of the bony insertion of the patellar tendon.

The technique of both these operations is described and illustrated. Abstracts of 16 cases are given. A summary of the views of several previous writers on the subject of recurrent dislocation of the patella concludes the article. A short bibliography is appended.—*Alexander Gibson*, *Winnipeg.*

The Treatment of Fractures. Major Tom. S. Mebane. *Military Surgeon*, Aug., 1922.

The paper deals in a broad way with the treatment of fractures and necessarily cannot be very specific. The author emphasizes the fact that much was learned regarding the treatment of compound fractures during the war, but that the institution of these methods into the treatment of simple fractures is bad and the tendency to apply war-time methods to treatment of simple fractures is to be condemned.

The author emphasizes the fact that a fracture should first be reduced and then splinted, and not depend upon any type of splinting alone to do the work. He takes up the common fractures, such as the Colles fracture, and in speaking of fractures of the shaft of the ulna and radius says that the forearm should always be placed in full supination.

The after-treatment is emphasized and physiotherapy given a definite place in the after-care.

The author's indications for operative treatment are rather limited. He says that fractures of the patella and fractures of the olecranon should always be operated on, and certain fractures of both bones of the forearm and lower third of the humerus very frequently require operation.

His summary is as follows:

1. All fractures should be splinted before transportation. For this purpose, except under war conditions, coaptation splints, Thomas or Keller leg splint, and Cabot posterior wire splint, are the splints usually required.
2. Many compound fractures can be converted into simple fractures by prompt application of iodine and a sterile dressing. Where considerable laceration of the soft parts has occurred, débridement with primary or secondary closure should be practised.
3. Infected compound fractures should be treated by Carrel-Dakin technique with suspension in Balkan frame and traction to preserve alignment.
4. Simple fractures and compound fractures present differences which require that they be handled differently.
5. Convalescence in fracture cases can be shortened and function conserved by employment of physiotherapeutic measures, early use of the part, and employment of braces and supports until callus becomes firm.—*M. S. Henderson, Rochester, Minn.*

THE DIFFERENTIAL DIAGNOSIS OF SPONTANEOUS FRACTURE-LIKE GRAINING IN THE BONES OF HUNGER OSTEOPATHY. W. V. Simon. *Archiv f. Orth. u. Unfall-Chir.*, 1920, xviii, 1-2H., p. 111.

Recently disturbances of the skeletal system have been observed, caused by disturbances of the endocrine system following faulty nutrition or infection. These bony changes are fracture-like splits in the graining of the bone and occur in young and old, and in both sexes. The lower end of the femur and the upper end of the tibia are most frequently involved, but the ribs, radius, ulna, neck of the femur, and pubis are also affected. The x-ray appearances of this condition show bony defects, roughly round, oval or elongated, and small in size. They begin at the cortex and extend inward, gradually enlarging as they penetrate the bone substance. The surrounding periosteum, cortex, and medulla are normal in some cases; in others the periosteum is thickened as in syphilis. These patients are ill-nourished and anaemic, and complain of pain over the bone involved. Pressure over the bone is painful and slight oedema is often present. It is necessary to differentiate between syphilis, periostitis, and late rickets and nutritional disturbances. The condition most resembles a small cortical gumma, but the Wassermann reaction has been negative in these un-

complicated cases. It can be differentiated from spontaneous fracture by lack of history of injury and because the defect occurs in a part of the bone not subjected to strain. Simon ventures the opinion that a syphilitic bone condition cannot be ruled out in some of these cases. In one such case, under arsenic, iodides, and calcium, a cure was effected in three months, although the Wassermann reaction was mildly positive a year later.—*Roland Hammond, M.D., Providence, R. I.*

RACHITIS.

SCHLATTER'S DISEASE.—A FREQUENT SYMPTOM OF LATE RICKETS. Bernhard Hinrichs. *Zeit. f. Orth. Chir.*, 1921, xli., 3H., p. 217.

Schlatter's disease is a functional disturbance of growth occurring at the time of puberty, affecting the tuberosity of the tibia, and running a chronic course, and usually resulting in a thickening of the tuberosity. There is transitory swelling on both sides of the ligamentum patellae, and in severe cases swelling of the knee-joint and atrophy of the quadriceps. After an exhaustive embryological study, Schlatter concludes that a locus minoris resistentiae exists at the junction of the upper part of the tuberosity with the lower part of the apophysis and that this is subject to pathological changes following injury. Periostitis at the insertion of the ligamentum patellae, partial fracture from pull of the quadriceps, osteochondritis, a rarefying process, apophysitis tibialis adolescentium, epiphysitis dissecans traumatica resulting in separation of a fragment of bone from the tibia, and inflammation of the pretibial bursa are the conclusions reached by various writers as to the nature of this condition. In many cases a localized inflammatory process is found in the tuberosity itself. Pathological changes at the junction of bone and cartilage have been found which closely resemble those of late rickets, as seen in adolescent knock-knee. There is evidence to show that a systemic disease is present, resulting in weakening of the tissues, which permits a rupture of the periosteum and resultant thickening of this structure. Similar periosteal thickening is found in other bones. While trauma, inflammation, and disturbances of growth are recognized as etiological factors in this disease, many cases have been observed in which the well-known symptoms of late rickets were present. The administration of phosphorus is suggested as likely to be beneficial. In conclusion the author states that in many cases Schlatter's disease is a symptom of late rickets. There is a tendency of the upper epiphysis of the tibia to show certain changes during the period of normal development which are induced either by direct or indirect trauma. In all cases where trauma is not a factor, late rickets must be taken into consideration. — *Roland Hammond, M.D., Providence, R. I.*

ADOLESCENT RICKETS. REPORT OF 5 CASES. Philip Lewin. *Surg., Gyn. and Obstet.*, July, 1922.

A short review of the literature is given, followed by detailed consideration of the etiology. In the writer's opinion, "it is entirely a question of bone meta-

bolism," including the influence of "endocrinology and vitamins." A suggestion is made that "disturbed thymus balance might cause bone and muscle changes."

The pathology and the symptoms of genu valgum and genu varum are then considered. Adolescent rickets has to be differentiated from osteomalacia and from osteitis deformans.

In regard to treatment the writer recommends osteotomy. The inevitable "Wolff's Law" is quoted in full. Histories of 5 cases are submitted. Numerous diagrams and photographs of two cases are included.—*Alexander Gibson, Winnipeg.*

NEOPLASMS.

CHRONIC BONE ABSCESS. Walter M. Brickner. *Surg., Gyn. and Obstet.*, July, 1922.

The author describes his technique for the evacuation of a chronic bone abscess. An incision about 2 inches long is made down to the periosteum. Through this and into the bone, a drill about one-fourth inch diameter is driven deep enough to permit the escape of pus. The drill is removed and nothing else is introduced into the bone. A small drain of folded rubber dam is laid in the soft parts down to, but not into, the opening in the bone, and the wound is otherwise closed by sutures.

The author then discusses reports by Bevan and MacWilliams of cases of chronic bone abscess in which primary and secondary suture respectively was followed by healing. A distinction is drawn between afebrile—presumably sterile cases—and febrile cases, which are really recurrent acute osteomyelitis. A full report is given of a case of bone abscess in the tibia in a patient, aged 32, who had suffered from osteomyelitis at the age of 11. Treatment by Brickner's technique was followed by two days of high temperature, normal being reached two days later. The patient left the hospital 24 days after operation. "A roentgenogram made 18 months after operation shows that the drill hole is closed by bone, but that the abscess cavity, although reduced in size, is not obliterated." "We should eliminate from our future text-books the statement that Brodie's abscess is usually tuberculous." Excellent advice, if necessary.—*Alexander Gibson, Winnipeg.*

ROENTGEN DIAGNOSIS OF THE MORE IMPORTANT TUMORS OF THE LONG BONES. Bernard H. Nichols. *Surg., Gyn. and Obstet.*, Sept., 1922.

Author has secured a remarkable collection of bone plates from the various hospitals of New York, representing practically all the types of bone tumors found in the literature. He has added a classification of bone tumors. (1) Their origin whether medullar or cortical; (2) Whether or not they are characterized by bone production, by bone destruction or by both; (3) The resultant condition of the cortex, whether expanded or destroyed; and (4) Whether they are invasive or non-invasive in their growth.

Malignant tumors do not cross a joint, as cartilage seems to be a barrier to malignancy, so that a lesion involving both sides of a joint is always a benign process.

Each type of bone tumor is described in detail and the article is beautifully illustrated.—*Thomas Madden Foley, Washington, D. C.*

MISCELLANEOUS.

KINEPLASTIC AMPUTATION OF FOREARM. TRIMOTOR. G. Bosch Arana. *Surg., Gyn. and Obstet.*, Sept., 1922.

The benefits to be derived from the regular practice of such amputations are incalculable. Kinematization, or kineplasty as it has also been termed, is a procedure which no operative method hitherto known can put into practice. By means of kineplasty there is constructed on the segment of the amputated limb a kinetic element termed "motor." Author began furnishing stumps with one motor (unimotor). He now uses three motors (trimotor). The technique is that described by Pellegrini. The first motor was constructed by suturing in handle form the superficial flexor muscles with deep tying flexors. The second motor was constructed on the under surface of the forearm with the common extensor muscles of the fingers. *The larger the motor "eye" the surer will be its practical results.*

Under Professor Putti's direction, the mechanical problem has been studied with singular success, and the orthopaedist, Fusaroli, has constructed a hand for a bimotor of forearm. This is the one which author placed on his patient. Article is well illustrated.—*Thomas Madden Foley, Washington, D. C.*

TREATMENT OF CHRONIC SYNOVITIS OF THE KNEE-JOINT. G. G. Atkins. *British Medical Journal*, June 17, 1922, p. 948.

The importance of this condition in army practice is pointed out. The knee-joint is full of fluid, while the vastus internus muscle is invariably wasted and cannot be fully contracted. In old-standing cases some lateral instability of the joint is usually present. Tenderness on pressure may be elicited over various points around the head of the tibia. In the majority of cases the semilunar cartilage is not at fault, and a diagnosis of injury to it should not be made unless there is a very definite history of locking of the joint at the time of the original injury. A strain of the internal lateral ligament is a common cause of chronic synovitis, and very often simulates a torn cartilage. The principal nerve of supply to the knee-joint also supplies the vastus internus, hence injury to the knee reflexly inhibits the action of this important muscle. So long as the vastus internus suffers lack of tone the effusion will recur at the slightest strain, hence one breaks the vicious circle by re-establishing tone in this muscle. This is done by increasing the blood supply to the area affected. (1) contrast baths; (2) limited active exercise of all the muscles about the

joint: and (3) massage. The patient is not confined to bed, but allowed light exercise over even ground. Occasionally a tight bandage over wool is applied to the knee at night. Tender points found at the insertion of tendons about the joint are due to local strain. Care must be taken in the diagnosis to eliminate intra-articular conditions, tuberculosis of the knee-joint, and also an effusion of the joint due to an hypertrophic infrapatellar pad of fat, in which case suitable limitation of complete extension must be provided for.—*J. A. Nutter, Montreal.*

DISTURBANCES OF EPIPHYSEAL NUTRITION IN MAN. Axhausen. *Münch. med. Woch.*, June 16, 1922.

A great many joint bodies are undoubtedly the end-result of a circumscribed traumatic lesion of the cartilage. But there is still another kind of free joint bodies, particularly in the knee. The characteristic of this typical "cartilage-bone" body is that a closed, non-fissured joint cartilage covering covers a uniformly wedge-shaped or oval necrotic piece of bone enclosing dead marrow, with no break in continuity to be seen. The origin of these epiphyseal wedge-shaped necroses, as found in the earlier stages of the typical cartilage-bone bodies, has proved experimentally to be completely impossible from a traumatic fissure. The author previously showed the formal agreement of typical cartilage-bone bodies in formation with the small tuberculous subchondral sequestra in the x-ray and spoke of his opinion that the question here, as there, was of a disturbance of nutrition by embolic plugging of the epiphyseal end arteries, only with the difference that in the preliminary stages of the free joint bodies the bacterial infection is of no concern or is quickly overcome by the body, so that only the mechanical effect of the vessel occlusion appears. The agreement between the joint body early stages and the tuberculous subchondral sequestra is not limited only to form, but extends also to the site. Such preliminary stages of the joint bodies appear in other joints. Koehler, in 1920, pointed to a unique pathological picture in the second or third metatarsal head, with an area of thickening surrounded by clear zones, flattening of the head, formation of a roll about the margin, broadening of the neck, and finally severe deformity. The demarcated, thickened, wedge-shaped bony part of the x-ray picture, which gives the impression of a tuberculous wedge-shaped sequestrum, histologically appears as an epiphyseal wedge-shaped necrosis. He rules out trauma as a cause, so that there remains no other possibility but an embolic-mycotic disturbance of nutrition, without any infection of concern. After such affirmations he believes that the mycotic wedge-shaped necroses, with infection excluded or quickly overcome, play an important rôle in the etiology of juvenile arthritis deformans.—*Armin Klein, Boston.*

A NEW METHOD OF MASSAGE AND ELECTRIC STIMULATION IN CONTRACTURES AND PARALYZED MUSCLES. Hanausek. *Revue d'Orthopédie*, July, 1922. Page 345.

The essence of this method is that the muscle should be relaxed while being treated. For example, in pes equinus the contracture of the achilles should be

overcome by stretching as much as possible during electric stimulation or massage of the paralyzed extensors. For maintaining this stretching the author uses stirrups and weights, arranged over pulleys if necessary. Some illustrations show at a glance the author's method of maintaining the deserved relaxation of the different muscles.

As far as I have observed, this method has been employed by all well trained workers here in America, so it cannot be regarded as a new procedure. However, it is well to call attention to it in order that it may be given deserved emphasis.—*William Arthur Clark, Pasadena.*

Further Report on Classification of Birth Paralyses as Endocrines. L. B. Clarke. *Southern Med. Jour.*, July, 1922.

The author believes that many of the so-called birth paralyses with mental and physical defects are in reality endocrine disturbances. Thirty cases have been studied and treated. Cretins are not included. Pluriglandular treatment has given best results. The younger the patient, the better the result. Four cases over seven years showed no improvement. One case of retarded mental and physical development is reported as completely cured. This case, as reported, does not seem to be a true congenital cerebral spastic type, and one wonders if he considers these hemi-, para-, and diplegics as endocrine disturbances.—*R. W. Billington, Nashville.*

Autogenous versus Heterogenous Bone Pegs. George de Tarnowsky. *Surg., Gyn. and Obstet.*, Sept., 1922.

The clinical behavior of a beef-bone graft depends entirely on the relative activities of the osteoblasts and the osteoclasts:

1. With proliferation of new cells from the living proximal and distal ends of the fractured bone keeping pace with absorption of dead cells from the graft, complete disappearance of the latter coincides with complete union of the fracture or filling in of the defect.
2. With hyperactive new cell formation and sluggish absorption, the graft constitutes a sequestrum which either eburnates and remains in a state of quiescence or acts as an irritant foreign body with sinus formation and periodic extrusion of dead bone spicules.
3. With hyperactive bone absorption and sluggish new-bone formation the graft disappears by combined extrusion and absorption before union or filling in of the defect has taken place.

The factors which enable us to attain the ideal, *i.e.*, an even balance of absorption and proliferation are: first, the thorough trimming off of dead bone proximally and distally with curette and chisel; second, firm approximation of the bone graft to living bone; and, third, absolute asepsis.

Finally it has seemed to us that the term infection, as applied to bone surgery, is too loosely used and that in many cases of so-called septic results we are merely dealing with type three, *i.e.*, rapid necrosis of the graft without in-

fection—using the latter term in its proper sense. In other words, subacute osteomyelitis, with no antibody reaction on the part of the individual, should not be classed as an infection but as ordinary tissue necrosis.—*Thomas Madden Foley, Washington, D. C.*

OSTEOGENESIS IMPERFECTA. Gg. Franke. *Zeit. f. Orth. Chir.*, 1921, xli, 1-2H., p. 158.

From an exhaustive study the author believes that the former separation of osteopsathyrosis idiopathica from osteogenesis imperfecta is unwarranted. The condition is not a symptom but gives the explanation of the bone process. Osteogenesis imperfecta is a disease of the osteoblastic cells of the periosteum and marrow, but the epiphyses are normal. In rachitis and in juvenile osteomalacia, which are constitutional diseases, changes in the cartilage are common. In osteogenesis imperfecta fractures occur before birth or in the early years of life, while in osteomalacia they occur around puberty, the period of greatest bony growth. The pelvis is involved in osteomalacia, a condition which is almost unknown in osteogenesis imperfecta. The cause of the brittleness of bones in osteogenesis imperfecta is found in the inadequate activity of the osteoblasts in normal enchondral ossification. In juvenile osteomalacia the bones are normal in structure, but calcium salts are absent.—*Roland Hammond, M.D., Providence, R. I.*

TYPICAL FLEXION CONTRACTURE OF THE GREAT TOE AFTER PROLONGED FIXATION. O. Kleinschmidt. *Arch. f. Orth. u. Unfall-Chir.*, 1920, xviii, 1-2H., p. 120.

Among the rarer deformities of the toes, there occurs a flexion contracture of the great toe at the metatarso-phalangeal joint following prolonged fixation of the foot after long recumbency in bed. In uncomplicated cases there was found a contracture of the flexor brevis hallucis muscle, together with a displacement of both sesamoid bones from the normal situation to the outer and posterior portion of the joint surface. In severe cases the sesamoid bones were fixed to the joint capsule by adhesions. The toe shows few changes beyond the contracture, and the other toes are normal. X-ray examination shows the displacement of the sesamoid bones mentioned above, and also in severe cases a flattening and broadening of these bones. The progress is usually favorable. Treatment by conservative measures such as baking, massage and active movements, failed in severe cases because of the severe nature of the contracture. Tenotomies or lengthenings of the flexor longus hallucis and flexor brevis hallucis were unsuccessful and extirpation of the head of the first metatarsal bone was rejected as too radical an operation. The best results followed the removal of both mesial and lateral sesamoids from beneath the metatarsal head. It was found necessary to sever by a transverse incision the fibrous tissue in which lies the tendon of the flexor longus hallucis. The foot is splinted with the toe in dorsal flexion. The results in three cases were excellent, with no functional disturbances, and the patient was up and around in two weeks.—*Roland Hammond, M.D., Providence, R. I.*

INDIVIDUALITY OF THE METAPHYSIS. R. Tillier. *Revue d'Orthopedie*, Jan., 1922.

Tillier comments on the actual existence of a metaphysis, more or less distinct and isolated, anatomically, from the diaphysis, as well as from the epiphysis, by transverse lamellae of bone. The latter are sometimes very distinct in young individuals, as he has demonstrated in long section of bones. This should be borne in mind in the reading of x-ray studies. Author goes on to discuss briefly the significance of a more or less isolated metaphyseal region as related to the localization and evolution of some pathological processes. Admitting that exceptions are many, most often tuberculosis originates in the epiphysis; syphilitic bone disease in the diaphysis; osteomyelitis in the metaphysis. Owing to its more acute character, osteomyelitic infection usually breaks through the anatomical barriers of the metaphysis; tuberculosis and syphilis are less apt to do so. Reference is also made to the possible influence of the transverse bone structure separating metaphysis from diaphysis in determining the site of fracture in certain cases; also, in regard to the shaping of certain deformities of growth.—*Roades Fayerweather, M.D., Baltimore, Md.*

ROENTGENOLOGY OF SYPHILIS IN BONE. E. H. Skinner. *American Journal of Syphilis*, Jan., 1922.

Syphilis in bone is usually a constructive osteoplastic process. The clinical findings are not as extensive as the x-ray findings.

Bone lesions cast shadows which are *constructive* in osteomyelitis and syphilis. Bone lesions cast shadows which are *destructive* in tuberculosis and malignancy. Bone tumors which are *constructive* are usually *benign*. Bone tumors in which *destructive* changes predominate are malignant.

The bone lesions of syphilis may be rated as constructive processes in all except syphilitic lesions of the plates of the skull. Charcot joint may be destructive but the great amount of calcareous débris thrown out at the enlarged joint indicates the constructive nature of syphilis of bone. The constructive character of syphiliric bone shadows is seen in the laminated veiling of the bones of the hand or foot in syphilitic dactylitis. Distinctly opposite shadow values are seen in tubercular spina ventosa, which shows areas of softening and local caries within a slightly expanded bone outline. Sabre tibia is a typical constructive process.

The joint lesions of syphilis, other than Charcot joint, rarely show violent destructive changes but lean toward hypertrophic pathology with perhaps an isolated area of softening in a localized gumma The zone of proliferative constructive reaction can be determined. This may confuse syphilis with Perthes' disease or Koehler's disease, but not with tuberculosis.

Bones seem to display a resistance to syphilitic invasion by piling up a positive resistance or a zone of defense, while in tuberculosis there is a negative resignation to the progress of the invader.—*W. G. Elmer, Philadelphia.*

CASES OF INFECTED KNEE-JOINT TREATED BY INCISION, DRAINAGE AND MOVEMENT. Philip Weatherbe. *Lancet*, Dec. 17, 1921.

After describing four cases of infected knee-joints, three of them being in children, and a perfect functional result having been obtained in each case, the author states the following conclusions:—

When the diagnosis is septic knee-joint, the treatment should be at the earliest possible moment a free opening of the joint by lateral incisions, four to six inches long on either side of the patella, followed by thorough irrigation of the joint, breaking down all adhesions, manipulation by full flexion and extension, introduction of several rubber drainage tubes about the size of the little or big finger according to the size of the patient, application over the wounds of wet boric lint covered with oiled silk, and creation of continuous drainage of the joint by capillary action.

The dressing should be changed once a day with removal of tubes, irrigation, and full flexion and extension. This should be repeated daily until the wounds are healed. Failure will occur if the incisions are not large enough, if the joint is not fully flexed each day, if the dressings are not kept wet.

The changing of dressings and movement of the joint are comparatively painless.

This method of treating septic knee-joints apparently gives the patient the best chance regarding his life and the function of his limb.—*W. G. Elmer, Philadelphia.*

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(1) Concerning the Disease Characterized by the Flattening of the Upper Epiphysis of the Femur. A. Legg, p. 585.

(2) Some Remarks on Coxa-plana, Wrongly Called Osteochondritis of the Upper Epiphysis of the Femur. J. Calvé, p. 592.

(3) On the Origin and the Final State of Coxa-plana. H. Waldenstrom, p. 599.

(4) Osteochondritis of the Hip and its Relation to other Osteochondritides of Infancy. G. Nové-Josserand, p. 606.

(5) Osteochondritis of the Hip in the Adult. L. Tavernier, p. 614.

(6) Some Remarks on Osteochondritis Deformans Juvenilis of the Upper Epiphysis of the Femur. E. Sorrel, p. 625.

(7) On Coxa-plana. G. Rottenstein, p. 633.

(8) Osteochondritis Deformans and Hypertrophy of the Upper Extremity of the Femur by Exostosis of Growth. P. Guibal, p. 644.

(9) Atypical Characteristics of Coxa-plana. J. Moreau, p. 652.

(10) Deformities of the Hip with Subluxation. M. Van Neck, p. 656.

(11) Consideration of Coxa-plana, Infantile and Adolescent. F. Delcroix, p. 659.

(12) A case of Osteochondritis of the Hip. Delchef, p. 669.

Archives Franco-Belges de Chirurgie, April, 1922.

This entire number of the Journal is devoted to that obscure condition of the hip joint known variously as Legg's, Calvé's, or Perthes' disease, osteochondritis juvenilis, coxa-plana, caput planum, etc.

Legg mentions briefly his first case, noted in 1905, which was being treated for tuberculosis of the hip, but which gave an x-ray picture very different from that of hip disease. He then describes the clinical picture as one of insidious onset with limp and little pain and slight limitation of abduction and internal rotation. A few months after the onset the x-ray shows the characteristic mushroom or cap-like deformity of the head and the thickening of the neck. In general, the malady runs its course without incidents. Occasional acute exacerbations are quickly relieved by fixation. The end-result is slight atrophy of the limb, slight shortening (1/4-2 cm.) and slight limitation of abduction and internal rotation. The x-rays of old cases show deformity of the head and neck out of all proportion to the small amount of disability. He refutes the theories of rickets, congenital anomaly, alteration in blood supply of the head, chondrodystrophia, infection, and syphilis as being the cause, and persists in his former belief that the condition is due to disturbances in the circulation of the epiphyseal line caused by trauma. His paper is illustrated by x-rays showing the evolution and the terminal state of the condition.

Calvé reports four rather unusual cases. The first followed an attack of chicken-pox, and the x-ray in the beginning was negative, but eight months later showed typical coxa plana. In one of the other cases the epiphysis had at one time completely disappeared and three and five years later had regenerated to a typical coxa plana. His first case he believes undoubtedly due to chicken-pox and the others had attenuated infections, sore throats, adenoids, etc. The cutaneous tuberculin reaction was negative in all of his cases. (His paper is illustrated with x-rays of the reported cases). He believes that clinically there is a latent stage of one to one and a half years preceding the osseous change, then the head atrophies and fragments and is later regenerated from the bony islets.

Waldenstrom believes that the condition is a disturbance in the function of the epiphyseal line, which begins between the ages of 5 and 7 years and leads to atrophy and fragmentation of head and later regeneration and slow evolution which lasts until adult life. He presents one case followed from the age of 7 years to the age of 21 years, with continued changes throughout this period. He compares coxa plana with Osgood-Schlatter's disease of the tibial tubercle, Köhler's disease of the scaphoid, apophysitis of the os calcis, and so-called congenital coxa vara.

Nové-Josserand's paper deals with atypical cases of coxa plana, and he asserts that lesions of the acetabulum are more frequent in this condition than are generally recognized and that all transitions exist between coxa plana, coxa vara, and osteoarthritis deformans juvenilis, and that all may present areas of decalcification in the neck. These conditions are either due to an entirely new disease of unknown etiology or certain individuals have tissues which are very susceptible to trauma or infections, which have no effect on normal individuals.

Tavernier begins his article with the statement that it seems paradoxical to speak of osteochondritis in an adult, but presents three observations of adult soldiers who developed hip symptoms after contusions, and in whom the x-rays showed marked deformity of head. Though it was not possible to obtain a history of any trouble in childhood these are regarded as cases of osteochondritis in infancy in which the symptoms were so mild as to escape the notice of the

parents. In these adult cases the clinical reactions were severe and may result in ankylosis. The osteochondritis may co-exist with osteoarthritis. The condition is due to some disease of unknown cause which in childhood affects the cartilaginous head, causing osteochondritis; in adolescence it affects the neck causing coxa vara, and in the adult the robust bone resists deformity and arthritis develops.

Sorrel remarks that the diagnosis is easy with the x-ray and the treatment is simple. He sketches the clinical and x-ray findings and does not accept any of the various theories of etiology as proven and feels that the condition may be due to some endocrine disorder. The immediate prognosis is good, as practically normal function is usually regained within two years, but from the reports of the old cases in the literature the end-results range from slight limitation of movement to almost complete ankylosis. However, as Sorrel points out, these severe cases were not observed in infancy and the diagnosis is questionable. Nevertheless, one is justified in giving a guarded prognosis as regards the ultimate result.

Rottenstein, from the x-ray standpoint, divides the condition into an early stage of atrophy and fragmentation of the head, a stage of repair, and a late stage characterized by osteophytes, deformity of the acetabulum, and ischium varum. He reports one case following the reduction of a congenital dislocation of the hip, a questionable case following pneumonia at the age of 3½ years, one case of bilateral coxa vara apparently following bilateral coxa plana, and one case associated with juvenile osteoarthritis deformans. He concludes that coxa plana may be due to trauma, chronic infections (syphilis or tuberculosis) or unknown affections, perhaps of the glands (endocrine).

Guibal reports a case of a man of 29 years who complained of acute attacks of pain in the right hip, lasting 8-10 days, the first attack at 17 years, and then no more until he was 28 years of age. Examination revealed an egg-sized tumor in the ilio-pubic region. The tumor was of bone and fixed to the pelvis. X-ray of the head of the femur showed it to be enlarged and mushroom-shaped. He considered the origin of the coxa plana to be the same as that of the exostosis; in the nature of a dystrophy appearing in adolescence; the flattening of the head being due to the body weight.

Moreau reports a case in a boy of 12, which is atypical in that it began at 10½ years with acute onset and severe pain, keeping the boy in bed a month and a half. At the end of this period he left his bed and walked without pain, and the condition pursued the typical indolent course. X-ray showed typical flat head, but also irregularity in the roof of the acetabulum. This case suggested infection by an attenuated organism.

Van Neck presents two cases of adult men subject to attacks of pain in the hip. X-rays showed femoral heads enlarged and flattened and the acetabula very shallow, resembling old congenital hip. He believes that these deformities are the result of an arthritis.

Delcroix presents a case occurring in a boy of 16 years, in which the symptoms were of abrupt onset and very severe pain. He compares this case with the coxa plana occurring in childhood. (This case is not really a coxa plana, but is a typical adolescent coxa vara). The pain is believed to be due to the deformity; hence the latent period in coxa plana in children. He regards the

condition as an osteitis, having an infantile and adolescent type with all gradations, depending upon the amount of ossification of the epiphysis.

Delchef presents a typical case of coxa plana which one and a half years later showed osteophytes around the border of the acetabulum. He regards the condition as an infection. (Not tuberculosis).

From the above symposium it is evident that in the present state of our knowledge coxa plana, Legg's disease, etc., are terms used to designate a certain anatomical change in the hip rather than a definite disease entity, and that even on the basis of the pathologic anatomy as revealed by the x-ray picture there is wide difference of opinion among various authors as to just what conditions can be included in this category. It is probable that a wide variety of pathologic influences may produce the pictures now rather loosely grouped as coxa plana. It is possible that future observations of cases followed for many years may enable us to separate out a dominant group as a definite disease entity with a definite cause and a definite prognosis, and several subsidiary groups which resemble coxa plana but are due to different etiologic factors and have different prognosis.—*J. A. Key, Baltimore.*

News Notes

Dr. J. Albert Key has recently moved to Baltimore, where he is engaged in the practice of orthopaedic surgery exclusively. He is connected with the University, the Hebrew, and the Kernan Hospitals of Baltimore.

Dr. Robert B. Osgood of Boston has been appointed the John B. and Buckminster Brown Professor of Orthopaedic Surgery at the Harvard Medical School and Chief of the Orthopaedic Clinic at the Children's Hospital, Boston.

Dr. Osgood has resigned as Chief of the Orthopaedic Clinic at the Massachusetts General Hospital.

Professor Henry Turner, of Petrograd, Russia, a corresponding member of the British Orthopaedic Association, would be grateful for the gift of reprints on orthopaedic subjects.

We append herewith a letter recently sent by Prof. Turner to Mr. Elmslie, the Honorary Secretary of the British Orthopaedic Association.

Petrograd, Baseynaya 15.

Dear Dr. Elmslie:—

Offering my cordial thanks to you for the kind invitation to the Annual Meeting of the British Orthopaedic Association, I beg you to be my mediator before the President of the Association in expressing my grief at not having been able to take part in the work of the Association. It is only lately that our connection with the outer world is being permitted. I sincerely hope to renew my ties with the much esteemed Society in a short time. You would do me a great favor if you could, with the Society's permission, send me

some printed material which would help to restore my knowledge of the progress of the western world in Orthopaedic Surgery. Any trifle would be accepted with gratitude.

Begging you to express my feelings of profound esteem to Sir Robert Jones and the Society, I remain with greatest respect,

Yours truly,

Professor Henry Turner.

The Section in Orthopaedic Surgery of the New York Academy of Medicine, of which Dr. Robert E. Humphries is Chairman, and Dr. Sigmund Epstein is Secretary, has held two meetings this season, with the following programmes:

Meeting, Friday evening, October 20, 1922.

PRESENTATION OF CASES.

From Bellevue Hospital:

a. Hemorrhagic Osteomyelitis of the Femur, two years after operation. Thos. A. Smith, M.D.
b. Torticollis.
c. Tuberculosis of the Knee with good function, 18 months after removal of diseased bone from joint.
d. Fusion of Extensor of great toe to Common Extensor of toes, for relief of drop toe.
e. Twist of Femur to prevent dislocation of Hip-joint following Infantile Paralysis.
f. Scoliosis following Spinal Fusion in a case of Fractured Spine.
g. Operation for relief of Ankylosis of Jaw, following fracture.
h. Operation for relief of Ankylosis of Radio-Ulnar joint.
i. Osteotomy of Femur and Tibia for relief of deformity causing pain in back, due to short leg. Reginald H. Sayre, M.D.

From St. Luke's Hospital:

j. A case of Achondroplasia with multiple lesions. Howard Urquhart, M.D.
k. Fracture of Cervical Vertebrae. Henry Scott, M.D. (*by invitation*)
l. Bilateral Epiphysitis of Hip in an adult. Frederick J. Matthews, M.D.
m. Chondrodystrophy of Hip, with surgical treatment. T. Halsted Meyers, M.D.

PAPER OF THE EVENING.

"Treatment of Obstetrical Paralysis." Illustrated by Lantern Slides.

James Warren Sever, M.D., of Boston (*by invitation*)

DISCUSSION.

Meeting, Friday evening, November 17, 1922.

PRESENTATION OF PATIENTS AND REPORTS OF CASES.

a. Full report of case of Fracture of Spine, presented by Dr. R. H. Sayre at the October meeting. Herman L. Von Lackum, M.D. (*by invitation*)
b. A cured case of Congenital Club Feet. Treated by corrective dressings.
c. Infantile Paralysis; leg useless for 18 years; operation and results. Charles Ogilvy, M.D.

e. Joint Mice in the Knee.
f. Joint Mice in the Elbow. Fred H. Albee, M.D.
g. Spondyloschisis.
h. Fragilitas Ossium. Samuel Kleinberg, M.D.
i. Three types of foot stabilizing operations. Elmer P. Weigel, M.D.
j. Operative fixation of Spine for Scoliosis. Barclay W. Moffatt, M.D.
k. Congenital absence of ribs, resulting in a marked Lateral Curvature.
Mark Cohen, M.D. (*by invitation*)

DISCUSSION.

PAPERS.

a. "Operative Treatment of the Residual Paralysis of Poliomyelitis."
Leo Mayer, M.D.
b. "Rehabilitation of the Cripple." Illustrated by Lantern Slides.
John Faries, M.D. (*by invitation*)

DISCUSSION.

The Annual Meeting of the British Orthopaedic Association took place in London on October 20 and 21, 1922. Sir Robert Jones, K.B.E., C.B., presided. The programme was as follows:

Friday, October 20.

MORNING SESSION.

(At the Royal Society of Medicine, 1, Wimpole Street, W. 1).

9:30 a.m. Executive Meeting.

10:00 a.m. Short Papers:—

1. "Tumours of Tendons and Tendon Sheaths." Mr. St. J. D. Buxton.
2. "Results of Tendon Transplantation for Intrinsic Hand Paralysis (Ney operation)." Mr. J. G. Johnstone
3. "Köhler's Disease of the Tarsal Scaphoid." Mr. E. S. Brentnall.
4. "Notes on Infantile Paralysis." Dr. Levick.
5. "Notes on some Complications of Supracondylar fractures." Mr. W. R. Bristow.
6. "Traumatic Myositis Ossificans in the region of the Elbow." Mr. H. Platt.
7. "Myositis Ossificans." Mr. Alwyn Smith.
8. "Types of Tubercle Bacilli in Surgical Tuberculosis." Mr. G. R. Girdlestone.

AFTERNOON SESSION.

2:00 p. m. At the Royal National Orthopaedic Hospital, Great Portland Street, W. 1.

7:30 p. m. Association Dinner (At the Langham Hotel, W. 1).

Saturday, October 21.

MORNING SESSION.

(At the Royal College of Surgeons, Lincolns Inn Fields, W.C. 2).

10:00 a.m. Exhibition of Pathological Specimens, arranged by Sir Arthur Keith. Discussion on the rarer forms of generalised bone deformities.

Dr. Calot announces his thirteenth annual course in orthopaedic surgery, given at 69 Quai d'Orsay, Paris, beginning the 22nd of January, 1923, and lasting for one week.

The course is for both physicians and students and may be taken in English as well as in French and Spanish. Further particulars may be obtained from Dr. Fouchet, Istitute-Calot à Berck-Plage, or from Dr. Colleu, Clinique-Calot, 69 Quai d'Orsay, Paris. The course will be repeated at Berck-Plage beginning the first Monday in August, 1923.

The programme will include the consideration of surgical tuberculosis, congenital and acquired deformities, fractures, and all the newer orthopaedic surgical procedures.

The Society of the Alumni of the Hospital for the Ruptured and Crippled, New York, held its Annual Meeting on November 27 and 28, 1922.

The meeting for the first day was held in the Operating Theatre of the Hospital and the following programme was carried out:

Morning Session.

(1) The Reconstruction Operation of the Hip.
  a. Its Indications.
  b. The Operation.
  c. Post-Operative Results. Dr. Royal Whitman.
(2) a. A New Method of Reduction of Congenital Dislocation of the Hip.
  b. A New Method of Approach for the Removal of the Semilunar Cartilage. Dr. Percy W. Roberts.
(3) Direct Hernia. Dr. J. P. Hoguet.
(4) Wedge Operation for Metatarsal Equinus. Dr. Richmond Stephens.
(5) An Improved Method for Lengthening the Tendo Achillis. Dr. Isadore Zadek.
(6) Demonstration of a New Fracture Table. Dr. Edgar Oppenheimer.
(7) Routine Operations. First Division Staff.

Afternoon Session.

(1) Observations on the Treatment of Simple Fractures. Dr. Charlton Wallace.
(2) a. End Results of Open Operation for Congenital Dislocation of the Hip.
  b. A New Bed Extension Apparatus. Dr. Percy W. Roberts.
(3) a. Report of Cases with X-ray Pictures illustrating the difficulties attending the early diagnosis of Sarcoma of the Long Bones.
  b. Patients showing End Results of Conservative Treatment. Dr. William B. Coley.
(4) Cases Illustrating Healed Bone Tuberculosis. Dr. Brainerd Whitbeck.
(5) A Case of Multiple Skin Graft. Dr. C. G. Burdick.
(6) Extirpation and Replacement of the Astragalus. Result at the end of fourteen months. Dr. William L. Sneed.
(7) Three Cases of Spondylolisthesis. Dr. Samuel Kleinberg.
(8) End Result of a Subcapital Fracture of the Neck of the Femur. Dr. Armitage Whitman.

(9) Orthopaedic Conditions following operations for Breast Amputation. Dr. Frank Adair.
(10) Result of Operation for Ruptured Quadriceps. Dr. Isadore Zadek.
(11) Unusual Tuberculous Disease of the Spine. Dr. Balensweig.
(12) a. Torsion of the Testis treated by Operation. Testis Saved.
b. Acute Haemorrhagic Pancreatitis. Operation and Recovery. Dr. Bradley L. Coley.

The meeting on the second day was held at the New York Orthopedic Hospital, and there the programme consisted of:

(1) The Pre-operative, Operative and Post-operative Treatment of Rotary Lateral Curvature of the Spine. Dr. Russell A. Hibbs.
(2) Demonstration of Cases by Members of the Staff.

The Eastern States Orthopaedic Club met at Toronto, November 24 and 25, 1922. The programme was as follows:

Friday, Nov. 24. Hospital for Sick Children.

Osteomyelitis. Professor C. L. Starr.
Living Sutures. Dr. W. E. Gallie.
Calcium in Bone Regeneration. Dr. F. F. Tisdall.
Clinical Cases. Dr. Bruce Robertson.
Fracture of Femur. Dr. A. B. LeMesurier.
Clinical Cases. Dr. Bruce Robertson.
"Insulin" in the Treatment of Diabetes. Dr. F. G. Banting.
Bone Grafts and Bone Pegs in Fractures. Dr. D. E. Robertson.
Operation for Slipping Patella. Dr. W. E. Gallie.

Saturday, Nov. 25. Christie Street Hospital.

Late Results of Tendon Transference.
Amputations.
Flail Joints and their Treatment.
Compression Fractures of the Spine.
Spondylitis.
Endarteritis Obliterans. Professor C. L. Starr.
Late Results of Nerve Injuries.
Heliotherapy in Surgical Tuberculosis.
Pedicle Skin Grafts.
Malunion. Dr. R. I. Harris.

Dr. George Barrie, a member of the American Orthopedic Association, died on October 15, 1922.

The next annual meeting of the American Orthopedic Association will be held in Rochester, New York, on June 7, 8, and 9, 1923.

Book Reviews

Lateral Curvature of the Spine and Round Shoulder. By ROBERT W. LOVETT, M.D., Sc.D., Boston, John B. and Buckminster Brown Professor of Orthopaedic Surgery, Harvard University; Member of the International Society of Surgery; Member of the British, French, Italian, and American Orthopaedic Societies; Member of the Swedish Society of Medicine; Member of the Royal Society of Physicians of Budapest. Fourth Edition. Revised with 172 Illustrations. Philadelphia: P. Blakiston's Son and Co., 1922.

The earlier editions of this book have served for many as a text book on scoliosis and round shoulders or poor posture. An ample insight into the theoretical knowledge of the conditions treated was to be had only by the reading of the book. In this fourth edition an entirely new chapter on the history of scoliosis has been added, and the illustrations have been changed a good deal. The book has been revised with many omissions, but some of the more important chapters, as for instance the final one, have been lengthened.

This last chapter is on faulty attitude, a subject of vital interest, but recognized as such much more in recent times by colleges, municipal administrative bodies, and by the medical profession as a whole. In this chapter the author describes his method of recording faulty attitude, as reported by Reynolds and himself. It is undoubtedly too intricate and expensive a method for the average physiotherapist or physician to use, and probably unnecessary because of the simpler shadowgraph methods now possible for getting the same outline of the body. If more had been written in an endeavor to stimulate a more widespread correction by education of improper, faulty attitude, a condition that is almost general, it would have formed a most welcome addition to this chapter.

The chapter on the treatment of lateral curvature is a calm, sober presentation of the different methods of treatment, with just emphasis on the extreme length of treatment necessary, and also on the importance of coöperation on the part of the patient. Correction by removable jackets, dwelt on by the author more than any other methods, and therefore most likely a reflection of the author's notions as to the better way of correcting certain forms of structural scoliosis, seems to be a time-consuming procedure. Some of the other forms of braces pictured in the earlier editions have been omitted from the discussion because of their displacement by jackets or corsets. The quadrilateral brace worn over a corset is, apparently, the only one recommended.

The most important principle in the book, however, is that of mobilization of the scoliotic spine. It should be obvious that better correction of the deformity would be possible if preceded by mobilizing gymnastics. And, of course, in dealing with patients admittedly physically subnormal, such mobilizing exercises can only be conducive to better general health.

This highly instructive book, with its excellent bibliography, should be of great value to the student wishing for a foundation knowledge of lateral curvature, a condition still obscure to most of us.

Body Mechanics and Health. By LEAH C. THOMAS and JOEL E. GOLDTHWAIT, M.D. Boston: Houghton Mifflin Company. 1922.

Pediatricians and orthopaedic surgeons are encountering a large number of patients in whom no organic lesion can be found, but who, nevertheless, are far from well. An extreme type of such cases would be represented by those whose symptoms may consist of convulsive seizures hardly to be distinguished from epilepsy, and by those who suffer from what is known as cyclic vomiting. There is then another large class of patients who fail to gain weight in spite of most intelligent and careful feeding. It has been discovered that many of these patients may be greatly benefited and their health restored by correcting their body mechanics. It is, therefore, very important that these methods of treatment, which are generally not appreciated and the details of which are generally unknown, should be described.

The book by Miss Leah C. Thomas and Dr. Joel E. Goldthwait would seem to fill a great want. Both of the authors have had a long experience in carrying out these corrective methods and are in a position to describe them authoritatively. The book itself is simple in construction and written for the lay as well as for the professional public, and is fully and adequately illustrated.

We believe that an appreciation of these defects and a knowledge of the methods of treatment should be in possession of all those who have to do with the physical education of children of school age, and the exercises described should be made a part of the regular physical education of all children showing these marked faults of posture. The scope of usefulness of the book is, therefore, very great, and we hope that its circulation will be large.

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The Journal of Bone & Joint Surgery

THE IMPORTANCE OF CORRECT FURNITURE TO ASSIST IN THE BEST BODY FUNCTION, AS RECOGNIZED BY THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY AND SMITH COLLEGE.

BY JOEL E. GOLDTHWAIT, M.D., BOSTON.

WITH the increasing consciousness that the right use of the body is desirable as part of the best health and general efficiency, it is not surprising that in 1915, when it became necessary to furnish the new buildings of the Massachusetts Institute of Technology, the matter of proper seating in class room and laboratory should have been given serious consideration. A highly technical institution such as this is, dealing with perfection of mechanical detail leading to the greatest possible conservation of mechanical energy, very naturally recognized the need of conserving the energy of the students through the proper adjustment of the human mechanism. To prevent the individual from breaking under the stress of professional responsibility was properly a part of such technical training, and since much fatigue or actual sickness is many times due simply to wrong use of the body, it was recognized that the seating problem was one of the first elements to attack. With this in mind, a committee was appointed by President MacLaurin, consisting of Mr. Horace S. Ford, the Bursar of Technology, Dr. Lloyd T. Brown, and the writer.

After much study, two types of chair, to meet the needs as presented, were approved,—one a "palette" arm chair for ordinary lecture room work and the other chair for work that involved much use of the seated body leaning forward, as working at a desk or table,—which were then manufactured by the firm of Heywood Brothers and Wakefield. The furniture used in the lecture halls, so-called "opera chairs," was not

Fig. 1.

Fig. 3.

Fig. 4

Fig. 5.

considered wholly satisfactory, but was finally approved as the best that could be planned at that time to meet the conditions as presented.

The "palette" arm chair was planned so that it would be possible for the body to be used with the least possible fatigue during lectures in which note-taking was expected. The proportions between depth of seat, height and shape of back, angle of back to seat, height of seat from floor, as well as the height and slope of the "palette," were all carefully determined after many anatomic studies involving individuals of different size and general proportion, as well as the best positions for avoidance of fatigue. In this latter consideration, the position and angle of the so-called "palette" was shown to be of the greatest importance, and that in most seats so equipped it is much too low as well as too flat. In the Technology chair, the "palette" is so placed that the student, in listening to a lecturer, would naturally sit with the body erect and with the head in the best position, while in writing it would not be necessary to change the body other than to incline the head slightly forward, as well as to lower the inclination of the eyes (Fig. 1). The usual droop of the body with the "breaking" at the waist line, as it is inclined forward to meet the needs of the ordinary "palette" arm chair, is unnecessary.

For the desk or bench chair (Fig. 2A) the proportions of height of seat, shape and inclination of back and other details were considered with the same care, the chief difference being in the depth and inclination of the seat. In the ordinary seat the depth is such that in leaning forward the weight is borne chiefly upon the posterior part of the thigh just below the middle, and this leads to such imperfect adjustment of the trunk and thigh muscles that it becomes extremely difficult not to bend at the waist line in leaning forward. This tendency is aggravated by inclination of the seat downward at the back, a feature that would be beneficial if the desire is for the erect seated position. With the shallow and nearly flat seat, the pressure upon the lower posterior thigh is removed, and in leaning forward the body rocks or balances upon the tuberosities of the ischia (the so-called hip bones). Under such conditions the bending at the waist requires effort rather than being the natural inclination, as in the other type of seat. The difference in the relatively flat seat of this chair and the inclination of the seat downward toward the back of the "palette" arm chair, where the erect position is expected, is clearly shown in Figs. 1, 2, 3, 4, 5. The natural position of the body taken as this chair is used, is shown in Figs. 3, 4 and 5, the forward inclination of the body taking place chiefly from the hip and not at the waist line.

Not only has this desk chair been used successfully at the Institute of Technology, but it has been accepted as the standard for seating in certain industrial plants, most notable that of the large clothing manufacturing concern of Joseph and Feiss at Cleveland, and is pictured in the bulletin upon "Industrial Posture and Seating" of the Department of Labor issued by the State of New York, April, 1921, as well as pictured with mechanical drawings (so that it can be easily copied) in the *Journal of Industrial Hygiene*, September, 1921, page 154.

Following the successful use of this furniture, and in keeping with the trend of education, which more and more realizes that it is desirable to have things done in the *best* way,—not carelessly,—when it became necessary to plan for the furniture for the student rooms in the new dormitories at Smith College, investigations were made which led to a committee being appointed to make recommendations. The committee was composed of Dr. Lloyd T. Brown, Dr. Robert B. Osgood (Professor of Orthopaedic Surgery, Harvard Medical School), Dr. Roger I. Lee (Professor of Hygiene, Harvard University), Dr. A. B. Emmons, 2nd (Director, Harvard Mercantile Health Work), Dr. Loring T. Swaim, with the writer as chairman.

As finally recommended, for the "study" or desk chair, the pattern adopted by the Institute of Technology and described above was selected, except that it was built on somewhat lighter lines. The chair is pictured in Fig. 2A, and in this, as well as with the chair designed for the Institute of Technology, no attempt at special adjustability was made. It was felt that whenever this was possible, experience showed that more often the adjustment was wrongly made than correctly, with harm rather than theoretical benefit resulting. A non-adjustable chair that would reasonably meet the needs of all types of individual was the task that was set for both committees. The ratio of height of chair to top of desk is fairly constant for all, and the difference in the length of leg is allowed in the shallow seat. With this it is perfectly possible for the individual with short legs to sit comfortably, since the thigh can be inclined downward fully thirty degrees before the posterior thigh rests upon the anterior edge of the chair, while with the individual with the long leg, the hip position is equally comfortable and there is naturally no disagreeable pressure upon the posterior thigh. With the shallow seat there is not the inclination to slide forward in the chair with the resulting "buckling at the middle" as is common with almost all chairs of the usual depth or backward downward inclination of the seat.

For the study desk (Fig. 3) it was agreed that a flat top desk is extremely difficult to use without bending at the waist line, and must

FIG. 2, a and b.

FIG. 6.

FIG. 7.

involve much change in the focal length of the eyes in covering a page for writing or reading. It was also agreed that most small desks are too low. The sloping top was finally adopted as not only inducing a better natural position in front of the desk, but in leaning forward there is not only very little tendency to bend at the waist line but the focal length for the eye between the top and bottom of the page is so nearly

the same that very much less eye adjustment is required than when the top of the desk is flat. The positions commonly assumed in reading or writing at the desk are shown in the illustration (Figs. 4 and 5). In these, as well as in the many tests that were made, there is very little tendency to bend at the waist line, which is the common posture with all flat top desks.

For the easy chair, it was finally decided that the natural physical requirements for the varying size and shape of the individual were best met by a "rocker" type. The balance of the rocker, the shape of the back, slope of seat, as well as height from floor, etc., were carefully studied, with the result as shown (Fig. 6). With a seat so proportioned there is very little tendency to slide forward in the chair, with resulting bending at the waist line, as is so commonly seen in the Morris and other types of easy chair, while the relief to muscle strain, which leads not only to the sliding forward in the seat but the other frequently seen positions of "slump" or "twist," is obtained by simply inclining the chair further forward or backward without changing the fundamental mechanics of the trunk of the body.

As still further evidence of the appreciation that furniture which encourages right use of the body is a responsibility that should be met as part of any college planning, the beds were selected so that the mattress would be relatively level and the spring not sag in the middle, as is so common with many inexpensive beds. During the periods of sleep the straight position of the body should be encouraged rather than made difficult, as is true of many of the beds on the market.

The furniture here described as used at Smith College was manufactured or provided by The Plimpton Scofield Company of Boston, and this concern has also made the Technology and Smith College desk chair in reduced size, this being considered the best school chair to meet the needs of children (Fig. 2B).

Recognizing the need of a suitable desk chair for executive use, the same firm has made, upon recommendation, a chair which fairly satisfactorily meets the needs. In this chair, as pictured in Fig. 7, there is very little tendency to slide forward in the seat with the undesirable buckling at the waist line, and the tipping mechanism is so adjusted that not only is the leaning backwards possible, but in leaning forward the front of the seat drops a little below the horizontal so that the weight continues to be borne upon the tuberosities of the ischia (hip bones) and is not received upon the mid or lower thigh, as is common in the ordinary chair. It is this latter feature which leads to the common "buckling" at the waist line with the resulting fatigue.

A STUDY OF GAITS.*

BY CHARLES LE ROY LOWMAN, M.D., LOS ANGELES, CALIF.

AMONG the many subjects of interest to us as orthopaedic surgeons, the matter of gaits is one which should receive more than our mere casual attention. There are two phases to this subject, one dealing with diagnostic values, with which you are all familiar, and the other with the factors of appearance—efficiency and utility of apparatus—and the relation to social and economic states.

Surgeons in general are altogether too prone to trust to nature to work out her own salvation after the active surgical procedures are over and the patient has been given some massage, exercise, and passive motions. The analysis of limps and their improvement and correction may seem to some an added refinement, but from the patient's standpoint it is important, and there is always a possibility of improvement by training in nearly every case of limping if anything like reasonable co-operation can be obtained.

After an injury to a lower extremity, or following some reconstructive procedure, it is not wise simply to instruct the patient to begin walking without crutches or with only a cane, because he will invariably be influenced by the fear of pain or of falling, and by the feeling of weakness, both local and general, causing the assumption of an unnatural posture and gait. This is true, although there may be no mechanical blocking of the affected area, and even when there is no expectation of any residual or permanent limp.

In orthopaedic cases where there has been a limp previous to corrective procedures, it must be remembered that instructions to walk usually mean walking in the old way; because after years of an established gait there are no motor memory patterns of any other way of progression. Frequently the old feeling of weakness or fear of pain will make patients exaggerate the limp which was previously present. Walking is a complex act and is influenced by any factor that disturbs joint action, muscle action, joint alignment, or proper weight bearing. Bone and joint dis-

*Read at the meeting of the American Orthopedic Association, held at Washington, D. C., May 1-3, 1922.

eases and injuries, paralyses, muscle contractures, and growth faults, comprise the chief sources of disturbances of locomotion.

For a number of years at the Orthopaedic Hospital-School Clinic, we have made it a definite procedure to assign these patients with limp to the gymnasium as soon as practicable after operative procedures or recovery from injuries affecting locomotion, with a definite prescription aimed at correction or modification of the faulty gait.

Gait can be definitely modified by correction of the faulty motor habits, and when definite mechanical factors leave a residual degree of uncorrectable limp, there can still be some improvement obtained by teaching the patient to maintain the best possible posture, and to cover up the worst features of the gait by assuming a certain mannerism which hides to a considerable degree the disability. For instance, the unsightly gait of the patient with old tubercular hip, healed in flexion and adduction, which requires the patient to step down on the affected side, with the pelvis thrust outward or backward and upward from the lordosis, is greatly changed by a subtrochanteric osteotomy, which makes a great improvement in general posture and position of the leg, but still leaves the patient with a stiff hip and a residual amount of necessary limp. A few weeks of training will make it possible for this patient to develop a special manner of walking which makes it seem unbelievable that the hip is actually ankylosed.

In brace-free cases with a shortened leg, with or without ankylosed knee or hip, we have found the design and adjustment of the shoe to be the most important single factor in affecting the gait and posture.

In the normal individual in walking after the stabilization of the knee by the action of quadriceps and hamstrings, the gastrocnemius and soleus are thrown on a tension and as they contract, the toe is thrust downward against the ground. The body is thus raised and propelled forward. As the body is raised on this leg, the opposite one is carried forward, and as it approaches the position to take the weight, the knee on the supporting side slowly bends, preventing a straight-legged upward thrust against the pelvis, thus allowing the body to be carried forward on a level. We should strive to obtain a similar action in our limp cases, *i.e.*, prevention of the abnormal pelvic and body movements.

In the shoe with high sole and heel the points of chief importance are: (1) the taper or roll of the sole, (2) the proportionate height of the heel to sole, and (3) the position of the heel on the shoe.

As to the first factor the shoe should carry the maximum thickness just back of the row of metatarsal heads, and should then have a taper forward whose curve of decreasing thickness depresses the forefoot and

raises the heel in an arc of motion simulating as nearly as possible the movement of the normal foot. In the normal foot the ground remains a fixed, constant factor, acted on by an inconstant factor which is in the leg; whereas, in a stiff leg, to keep from thrusting the hip upward and to maintain the movement of the body forward on a level, the fixed, constant factor must be in the straight leg, and the inconstant factor in the sole of the shoe.

The value and effect of much high class surgery can be greatly minimized, in fact almost wholly lost, if proper study and observation is not applied to the subsequent shoeing or bracing. It is bad enough for a weakened, paralytic leg to have to carry a heavy shoe in order to prevent pelvic tilt and a secondary scoliosis after a foot and leg has been re-aligned and stabilized, but it is worse to suffer the improper twists and thrusts of poorly designed corrective shoes. It is of little use to correct the injurious thrusts and stresses produced by the deformity, and then subject the parts to strains that are equally wrong after the deformity is corrected.

Too often the surgeon simply gives the bracemaker or shoemaker a prescription specifying the height of the heel and sole, to be made by them according to some fixed design which has been used regularly as a type. For instance, during my army experience, I cannot recall having seen one high sole or patten, of the many which came under my observation, that was not heavy, ungainly, and absolutely faulty in construction, its only evident purpose being to supply needed length for the short leg.

The relation of thickness of sole to that of the heel should be determined (1) by the amount of toe drop desired, (2) by the character of the step taken in relation to the propelling power of the rocker whose initial thrust begins at the thickest part of the sole, and (3) by the amount of actual muscular effort developed in foot and leg, especially in the gastrocnemius.

The shape and position of the heel also needs attention. There is a general tendency on the part of shoemakers to attempt to improve the appearance of such shoes by tapering the heel down from seat to base. This greatly increases the instability, although it lessens the weight somewhat. Generally speaking the base should be as wide as the seat, and by concaving the sides and back, and slanting the back a little forward, the same improvement in appearance is accomplished without losing stability. The heels should be extended on the base inward or outward from one-quarter to one-half inch in accordance with the need for a corrective lateral thrust to control valgus or varus.

The usual method of dropping the toes into rather marked degrees of equinus and allowing the insole to slant downward from the back of heel to toe is also faulty and a practice affected largely by makers of deformity shoes, the heel being built up the required amount, making it much longer on the back than on the face or breast of the heel. This construction allows the foot to slide forward in the shoe, making the dorsum and toes take the thrust, whereas, the correct procedure is to mold the shank up and keep the heel seat flat. In fact, putting a thickened pad on the insole in front of the heel aids greatly in preventing this slippage.

The adjustment of the heels on the shoes for astragalectomized feet, and those repositioned by transverse section with backward displacement requires considerable study and constant watching of the brace shop in order to get the best results. By following a suggestion received from Dr. Lord, a year or so ago, we have greatly improved the shoes for these cases, and ever since for prescription purposes have designated this heel in our clinic as the "Lord heel." After the weight bearing thrust on the foot has been altered by reposition operations, the heel in the usual position on the shoe is too far back. When it has to be over two inches high this posterior position makes too much weight in an unnecessary and useless place. It also makes the heel strike too soon, transmitting no thrust on the shank, but rather tending to break it, because the space between the heel breast and sole is too long. This position of the heel also undoubtedly assists in causing or increasing a tendency to rotate the leg out and produce a valgus thrust on the foot. To overcome these faults, Dr. Lord suggested that we try setting the heel forward more under the line of the tibia and cut off the excess of heel behind, sloping the back of the heel downward and forward. This produces a thrust upward on the shank and allows the heel seat to remain level. We have been grateful ever since for this helpful hint which I am passing on to you.

As to shanks, we have found that rigid ones are more lasting and least harmful to the feet. When the sole is thickened and the shank left flexible, a breaking strain is thrown upon the foot in the mid-tarsal region only. The strain is not distributed through the whole forefoot as it is in the sole of normal thickness. Furthermore the shoe breaks down and the necessity for frequent repair or replacement is a hardship on people of meagre means. Either the wood, cork, or leather can be made from one-half to three-quarters of an inch thick through the shank, or a metal bridge between sole and heel can be used to support the shank.

We have tried various materials in making the high soles, and are at

present experimenting with Balsa wood, which is as light as cork, but is so soft it will not hold a nail even an inch long. We have tried cementting the block between two leather soles and running a long screw down into the heel from the inside of the shoe. When willow wood is used it is important to bore holes in the block to lighten it. Metal extensions are not satisfactory because the leverage pulls the screws out of the leather, and so many screws have to be used that the shoe is very heavy.

In cases with short legs of the dangle type, the use of the Thomas ring splint, calipered into the high sole, has given the most satisfaction, particularly when the abductor group on that side is weak.

The film which I am presenting is shown, not only to illustrate the subjects of gaits, but to show a method of study of our cases at the Orthopaedic Hospital-School. After operative corrective procedures have taken place, one never has the original condition before one again, and in a busy clinic it is hard enough to have even the records show the exact deformities and positions of the feet—to say nothing of having any very exact recollection of their action. A note to the effect that the foot was originally in valgus does not give any clear idea of how the child used the foot in relation to faulty muscle action higher up. With motion picture records of the more important cases, studies of the original action in comparison with that subsequent to the various corrective procedures are of great value in determining further treatment.

A CLINICAL STUDY OF THIRTY CASES OF MUSCULAR DYSTROPHY.

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THE cases of progressive muscular dystrophy here presented were examined at the University and Children's hospitals between the years 1916 and 1921. They have been studied chiefly from the following standpoints: clinical, metabolic, myotonic, and ergographic.

Historical[1].—It was not until 1850 that pseudohypertrophic muscular dystrophy, as a clinical entity, was described by Aran and Duchenne, although mention was made as early as 1709 of a similar syndrome. Shortly after this, Cruveillier put forth his theory of the spinal origin of this condition as a result of lesions which he found in the region of the anterior horn cells. This finally led to a heated argument between the neuropathic and myopathic theories. Charcot, Jaffroy, and Luys were the chief supporters of the neuropathic theory. Duchenne, who had advocated muscular origin, later came to adopt Charcot's views. Friedreich opposed the neuropathic theory. In 1878, Lichthein reported an autopsy in which there were no lesions of the spinal or peripheral nerves, but some signs of fat infiltration in the muscles. Nerve lesions have certainly not been a constant finding and in many cases in which they are reported there is reason to doubt the value of the observation or the correctness of the diagnosis. Erb,[2] in 1882, distinguished two types: the spinal atrophic type and the musculo-dystrophic type, and collected all the types into one group under the name "Dystrophia Muscularis Progressiva." This was subdivided clinically into two main groups:—

1. Progressive muscular dystrophy (infantile type).
   a. Hypertrophic form (Fig. 1):
      1. With pseudohypertrophy.
      2. With true hypertrophy.
   b. Atrophic form (Fig. 2):
      1. With primary facial involvement.
      2. Without facial involvement.
2. Progressive muscular dystrophy (juvenile and adult type) (Fig. 7).

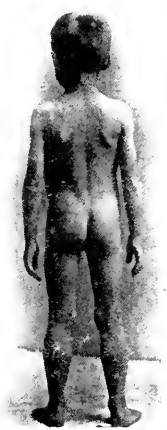

Fig. 1.—Pseudohypertrophic muscular dystrophy, early stage.

Fig. 2.—Late atrophic stage of muscular dystrophy.

The first group begins early in life, almost always before the twelfth year, and often develops rapidly. Death often occurs between the fifteenth and twentieth years. There is weakness of the upper and lower extremities, usually hypertrophy of the calves and biceps at the onset, waddling gait, lordosis, and later atrophy and contractures. The second group begins around the twentieth year and lasts 20 to 40 years, with remissions. It starts usually in the shoulder girdles, often with hypertrophy of the biceps and atrophy of the serrati magni, supra- and infraspinati, and the pectoralis major. It may later extend to the lower extremity, with atrophy of the glutei and extensors of the foot, and with pseudohypertrophy of the calves. In neither the juvenile nor the infantile forms is the reaction of degeneration present, nor are there any fibrillary twitchings. Erb reports pathologically an increase in the nuclei, normally and abnormally placed, with either an increase in the volume of the muscle fibers or else an atrophy, even to complete disappearance. Goodhart and Globus,[3] however, state definitely that we do not see true hypertrophy in the dystrophies.

Barsickow,[4] in 1871, made a study of an unusually interesting collection of cases. In one family the great-grandfather developed the disease between the twentieth and thirtieth year and was affected only to the extent of stiffness of gait and carriage. He lived to a ripe old age. In the five generations which composed the series an equal number of males and females were affected. In 17 cases the age of onset was as follows: five cases between 10 and 20 years, seven cases between 20 and 30 years, and five cases in later life. Lordosis, winged scapulae, and a waddling gait were prevalent. Out of 11 cases, nine lived 58 years or longer, one living for 80 years. No fibrillary twitchings were noted, but fatty infiltration of the muscles was encountered. This group of cases was evidently of the Erb juvenile type.

According to Timme,[5] Gowers in 1879 collected 220 cases from the literature. Of these, 190 were males. Some of Gower's conclusions are:

1. The disease is almost never known to be transmitted through the father.

2. The date of onset is important; the younger the age of the onset the poorer the prognosis.

3. Pes equinus is the most constant contracture.

4. The patient usually loses the power of standing at 10 to 12 years and death comes on from 14 to 18 years.

Landouzy and Déjèrine,[6] in 1885, described two cases. On one an autopsy was made. Not finding the spinal cord changes expected, they

considered this case as a clinical entity, differing from the Duchenne-Aran type. One of their two cases was classified as myopathic, facio-scapulo-humeral type, the other, showing no facial changes, as scapulo-humeral type.

No less striking than Barsickow's family collection is that reported by Timme. In four generations of one family there were 31 children in all. Of these, 14 were affected, eight males and six females. Five were examined by x-rays, four of these "showing distinct changes about the pineal glands." According to Timme the fifth showed an enlargement of the sella turcica. He thinks there is a definite relationship between the pineal glands and the disease, and as a check he examined 150 x-rays of the head in unaffected individuals and found only two with pineal shadows. He further supports his theory by the fact that the pineal gland is supposed to cease its function at puberty.

Brock and Kay[7] report a case of dystrophia adiposogenitalis associated with muscular dystrophy, showing shadows in the x-ray about the hypophysis.

Marina,[8] in 1908, reported an eight-year-old girl who had signs of pseudohypertrophic muscular dystrophy, who, after an interval of five years, returned for re-examination entirely well. He corresponded with Erb, asking his experience in this respect. Erb replied that he had seen one English girl who had recovered following menstruation, when normal glandular function was resumed.

In the recent literature there have been many cases reported from various aspects. The typical clinical picture is often complicated with other syndromes. Eulenberg[9] reported a case combined with acromegaly. Kaumheimer[10] reports a case in a child of five years after an attack of infantile paralysis. Milio[11] reports nine cases between the ages of six and eleven years where there was no hereditary factor, but in some cases there seemed to be a definite connection with acute infectious diseases. Collins and Climenko,[12] in a study of 50 cases reported a frequent association with other anomalies such as faulty teeth, general glandular enlargement, and high palate. Jendrassik[13] reports two cases of recovery following menstruation. He also cites the above-mentioned cases of Marina and Erb. Other cases of muscular dystrophy are reported by Rice,[14] Pirtle[15] and Bötner.[16] Reichmann[17] and Schuster[18] have written comprehensive articles with collections of cases. Finlayson[19] reports a case with onset at the beginning of menstruation. His case was quite definitely the facio-scapulo-humeral type and progressed rather rapidly.

Etiology.—In recent years some authors have brought out strong evi-

dence in favor of one or another of the endocrine glands. The trend of research seems to have gone almost entirely in this direction. The exponents of the pineal theory base their claims upon the similarity of symptoms to those in the proven cases of pineal tumor, *i.e.*, muscular weakness and fatigability followed by contractures and inability to walk, and occasionally involvement of the eyes due to pressure on the corpus quadrigeminum. The pineal shadows normally, they claim, occur only occasionally and only in adult life.

In Timme's five cases, four out of five showed pineal shadows; these cases were under 24 years of age. In the cases of pineal tumors reported by Pierce Bailey and Jelliffe[20] the symptoms resemble in many respects those of muscular dystrophy,—weakness of the lower extremities and waddling gait being among the characteristic features.

In his case of "adrenal insufficiency" Williams[32] reported lassitude, low blood pressure, and weakness of the limbs, especially in the morning. McAuliff[21] thinks there is a definite connection between the suprarenals and the secondary sexual characteristics of the female. Janney, Goodhart, and Isaacson,[22] in a study of nine cases, old and young, severe and light, think that muscular dystrophy is a result of dysfunction of the ductless glands affecting carbohydrate metabolism. In this series there were eight males and one female; there was definite familial tendency. Levi and Rothschilds[23] reported improvement of a myopathic condition from pituitary extract. Goodhart and Globus[3] in 1918 reported two cases of muscular dystrophy in which they found areas of cicatricial tissue in the heart muscle. Finding no "Aschoff bodies" and no other signs of infection they conclude that the changes were a part of the dystrophic syndrome.

Ergographic Records.—A. Gibson[24] has reported a case of familial "muscular infantilism" much resembling dystrophy, in an adult male; he was unimproved by thyroid or suprarenal therapy. The ergographic findings in this case, taken with Mosso's[25] ergograph showed that a small load could be raised almost indefinitely; however, a normal load could not be raised at all.

This seemed to be the case also in our ergographic experiments with the dystrophic cases. In children the ergographic record could be only a rough estimate, as it is difficult to get their entire coöperation. In one typical case, a boy, 10 years of age, the greatest weight that could be used was one-fourth kg. He was able to make a five-minute record, con-

FIG. 3.—X-ray of the skull showing no definite pathology.

tracting every two seconds, with no marked variation in the height of the contractures.

A record was also made of a child with infantile paralysis involving the upper extremities. The thumb and index finger of the left hand were partially paralyzed, and the paralysis extended to some extent to the other flexors of the fingers. The record as usual was made with the middle finger; the same weight was used. In five minutes the tracing had reached a level of almost complete fatigue.

X-Rays.—The x-rays of the skull showed no definite shadows in the region of the pineal glands (Fig. 3); in two cases, however, there were enlargements of the sella turcica. X-rays of the long bones showed some thinning out of the cortex but no epiphyseal enlargements, and no gross atrophic changes (Fig. 4).

Metabolism.—McCrudden and Sargent,[26] Janney, Goodhart and Isaacson,[22] Brock and Kay[7] have reported a low amount of blood sugar in

myopathies. There was also in most of their cases a creatinuria and a low sugar tolerance.

Inasmuch as carbohydrate deficiency induces creatinuria, it has been argued that the faulty carbohydrate metabolism is responsible for the muscular changes.

FIG. 4.—X-ray of long bones showing mild atrophic changes.

We are indebted to Dr. R. B. Gibson,[27] of the chemical research laboratory of the University of Iowa College of Medicine, for his careful metabolic studies in ten of our cases. He is inclined to believe that the actual diminution of the amount of muscle tissue functioning is the condition inducing creatinuria, since he found creatinuria also in the cases of infantile paralysis which he studied. Yet, in the infantile cases the carbohydrate metabolism remained normal.

The metabolic findings may be summarized as follows:

1. Those due to muscle atrophy.

A. Creatinin.

a. Lower creatinin excretion in the urine, and in the blood the lowered creatinin coefficient (%).

B. Creatin.

b. Creatinuria (not present in normal individuals).

c. Recovery in the urine of creatin when fed.

d. Creatin in the blood.

2. Due to "endocrine disturbances."

a. Low amount of sugar in the blood.

b. Excretion of sugar in the urine when fed in amounts usually tolerated (lower sugar tolerance).

The eight cases of progressive muscular dystrophy in boys and two in adults were studied metabolically. The result of the investigation is, therefore, the increase of the output of creatin in the urine, on one hand, and the low sugar tolerance in cases of muscular dystrophy. Both of these factors seem to keep step with the progress of the muscular changes, and consequently it seems possible to judge the severity and malignancy of the process by the metabolic picture.

Cases.—Owing to the large number of cases we cannot at the present time give a detailed report, but instead the cases have been generalized into their respective groups. The group arrangements of Erb, and of Turner and Stewart,[28] in their text book of nervous diseases, do not differ essentially. We feel that the hypertrophic and atrophic types of the infantile form should not be strictly differentiated, as it appears that these two conditions may often follow one upon the other in the normal course of the disease. In this series of dystrophy cases there were 25 males and five females. The female cases do not seem to have any individual characteristics.

The average age was 13.5 years; oldest, 38 years; youngest, two years. The average age of onset was five years; oldest, 21 years; earliest, a few weeks after birth.

In looking into the hereditary tendency, there were in the group of cases examined, two striking instances. In one family there were four children, two boys (Fig. 5) and two girls; all developed typical muscular dystrophy at an early age. The oldest, now 11 years of age, is unable to walk. In another family the mother was married twice. By her first husband there were three boys and one girl. All the boys developed muscular dystrophy and died; one died in infancy, one at the age of eight years, and one at the age of 18 years. By her second husband there were two boys and two girls. All the girls are living and show no evidence of the disease. Both boys were presented here for examination and showed typical muscular dystrophy, and one has since died of influenza. In two other instances there were respectively cousins and uncles and

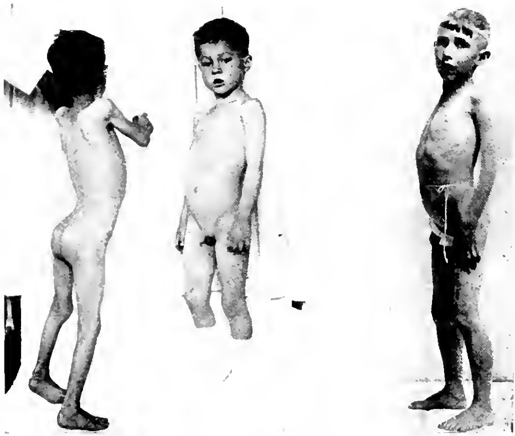

FIG. 5.—Brothers with muscular dystrophy, one early stage, the other a later stage.

FIG. 6.—Very typical attitude in the most common forms of progressive muscular dystrophy.

brothers of the mother affected. There were four instances of either extreme nervousness or insanity on the maternal side. The rest of the cases were isolated ones, almost invariably only children (Fig. 6).

Groups.—Of the 30 cases, four were of the juvenile form (2), coming on at the ages of 12, 15, 18, and 21 years, and usually starting as the upper girdle type. The other 26 were of the infantile form (1), and more frequently started as the girdle type, the weakness being noticed in the lower limbs, with difficulty in getting up from the floor and in going upstairs. Stumbling, lordosis, waddling gait, and loss of reflexes were the characteristic symptoms.

Twenty-four cases were of the infantile type, either hypertrophic or atrophic form. In this group of infantile cases, seven were tested at intervals of two to 12 months by means of Lovett's[33] spring balance test; some showed a definite progress of the paralysis; others showed no change after six months, one case after 12 months. One case in this series, a boy nine years of age, seen two years after onset, showed much improvement and a definite gain in strength after two years of observa-

tion. The condition seems now to be arrested and the mother reports that he is making a daily gain in strength and she believes him cured. In two other cases, records were made on admission to the hospital, after three days of rest, and then after one day of exercise. The exercises consisted of walking up and down stairs. The records showed that after rest in bed for a few days the muscle action was distinctly weaker than on admission. After exercises all day there was a slight increase over the records after rest. However, in neither of the cases was the rise great enough to equal the original spring balance test on admission.

There were two cases of the facio-scapulo-humeral type. Seven cases were beyond the walking stage and had various contractures.

Treatment.—Twelve cases were treated for two weeks to three months with various glandular extracts (pituitary, adrenal, parathyroid, and pineal) without any appreciable effect. Seven cases were treated with calcium lactate and 11 with massage and exercises (either with or without glandular treatment). We feel that calcium lactate is of some benefit. Pemberton[29] reports a marked loss of calcium in the blood in two cases. Rosenbloom and Cohoe,[30] reporting a case of myatonia, think that the decrease in the calcium may play an important rôle in the muscular weakness. Apparent retardation of the progress seems to have been accomplished by means of autohemic serum.

Twelve of our cases were slowly progressive, eight moderately, and nine rapidly progressive. Wassermann tests made on 14 cases were negative. The microscopic blood picture was normal in six cases examined. The reflexes were either absent or greatly diminished in all cases, with the exception of the cremasteric and abdominal reflexes, which as a rule were present. Microscopic examination of muscle, made in four cases, showed the fibers to be pale, with diffuse areas of granular degeneration and vacuolization. There were also areas of fat infiltration between the muscle fibers. The striations were present except in a few places where complete degeneration had taken place.

Of the 30 cases, 23 are known to be living, three are dead from intercurrent diseases, and four have not recently been heard from. In none of the cases was there any tangible connection between the onset of the disease and acute infectious diseases. In no case was the onset acute.

The following two cases were of particular interest:

Case 1. O. Smith, a man 38 years of age, came to the hospital for relief of his weakness (Fig. 7). This he first noticed when 18 years of age in the muscles of his right forefinger; gradually the weakness extended to his shoulders and later to his hips. As the disease progressed

FIG. 7.—Adult case, of the adult form, duration 20 years.

the calves became hypertrophied. He had great difficulty in going up and down stairs. Later, there was a waddling gait, lordosis, and marked atrophy of the muscles with protrusion of the shoulder blades. In spite of his weakness he could when once on his feet walk for long distances, and do a certain amount of work. Upon examination he was able, with great difficulty, to get up from the floor. This he did in a way very characteristic of the dystrophy cases. He walked somewhat on his toes, but the foot did not assume a position of equinus when he was standing. There was marked atrophy of the muscles of the arms, shoulders, chest, and thighs, particularly the serratus magnus, supra- and infraspinatus, biceps, and triceps, intercostals, glutei, and hamstrings. There was some hypertrophy of the calves, but facial muscles were not involved. All reflexes except the cremasteric and abdominal were absent. His metabolic picture was characteristic of a slowly progressing muscular dystrophy; the blood was normal and the Wassermann negative. Unfortunately no radiograph of the head was made. He was given a reinforced corset for support. He reported two years after examination that his condition was about the same.

CASE 2. Oscar S., 15 years of age, was admitted to the hospital for

paralysis, giving the following history: The condition was first noticed when he was four years old. At that time he was able to walk about and use his hands. However, since then he has gradually become weaker, and to add to his difficulties, has also become very obese. For the past three years he has not been able to walk.

The examination shows him to be an extremely obese boy, with an intelligence almost normal; the pubic hair is missing, and the sexual organs small. His weight is 250 pounds and he is unable to stand. The calves are enlarged and hard; he is unable to flex his knees and can scarcely flex his elbows. The reflexes are entirely absent. The fat distribution is very extensive on his back and neck. The patient presents a combined picture of dystrophia adiposogenitalis (Fröhlich's syndrome; Ebaugh and Hoskins[31]) combined with progressive muscular dystrophy. The x-ray shows the sella turcica irregular and indefinitely outlined. The anterior-posterior diameter of the sella was 14 mm.; the superior-inferior diameter 9 mm. Of the muscles, the calf muscles are the strongest, being approximately one-fourth their normal strength.

The patient died two months after admission, of influenza, and an autopsy was obtained. The anatomical diagnosis was as follows: Double lobar pneumonia; septic splenitis; fatty infiltration of the liver; enlarged thymus; enlarged parathyroids; edema of the brain; cyst of the hypophysis; replacement of skeletal muscle by fat tissue, and muscular dystrophy—pseudohypertrophic. No gross pathology of the pineal gland was found.

The additional microscopic diagnosis was as follows: Edema of the heart; focal necrosis of the adrenals; ingrowth of fat tissue into the parathyroids; healed tuberculosis of the lymph nodes, and engorgement of the anterior lobe cells of the pituitary body with hyaline droplets. In regard to the parathyroids, Dr. Medlar, the pathologist, makes the following note: "If these structures were accessory thyroids, the parathyroids were so small that they could not be detected in gross examination."

Summary.—In summarizing it seems very hard at the present time, either from the evidence presented by many authors, or from our own observations, to draw definite conclusions as to the etiology of the progressive muscular dystrophies. If we allow ourselves to be influenced entirely by the theories of endocrine origin we find many stumbling-blocks. It is hard to believe that a cystic tumor or other pathology of one of these glands can always locate itself in just the place to cause repeatedly the identical or almost identical clinical entity. The evi-

dence introduced in this respect does not always seem to be entirely sound. On the other hand, the recoveries reported in the literature and in our own series seem to be beyond question. There is not in progressive muscular dystrophy the low fatigue coefficient, within physiological limits, that one would expect to find. The muscle fibers which remain unaffected from the disease seem to be acting to the extent of their normal limit. But there seems to be not "enough ammunition to go around." Is it a matter of waste product elimination? Are a part of the muscle fibers in their physiological capacity of glycogen builders and storehouses, or as secretors of sarcolactic acid and carbon dioxide, failing in their work?

It is generally conceded that there is a low amount of blood sugar, and that sugar when fed is rapidly excreted. Has something happened to the muscular substance which should activate the transforming enzyme? We need more autopsies; we need more pathological studies; more chemical studies; and we need more research by men who go into their work with a good substantial knowledge of what has already been said and done on the subject.

In making this synopsis of our cases we have come to the realization of its possibilities, and the meager work which we have presented will be followed up in the immediate future by a more thorough, and we trust, more enlightening series of experiments.

I am indebted to Dr. Steindler, in charge of the Orthopaedic Service, for the privileges extended me in the use of the cases and for his cooperation and valuable advice.

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THE TYPES OF TUBERCLE BACILLI CONCERNED IN SURGICAL TUBERCULOSIS.*

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I FEEL that you will expect me to begin with an apology! For I am reading a paper dealing with bacteriology and am no bacteriologist! But though the experimental work has been done by others, much of the material has come from cases of joint and bone tuberculosis under the care of members of our Association and in particular of Sir Henry Gauvain. Facts of great interest have resulted from this work, but there is still much to be found out. The papers dealing with this piece of research have been published in various journals which I fear many of us do not find time to read, so the data and conclusions may be of new interest; further sources of material may be made available for a continuance of the research;† so that I feel that no apology is really needed.

My own interest in the matter is of very long standing. It has been revived of late in that the thorough organization of after-care has made it possible for us to keep in touch with cases for many consecutive years so that opportunities of recovering material from cases at long intervals are likely to arise. I feel that the subject is of interest to all dealing with bone and joint surgery, and that some of the data are suggestive as to treatment.

EARLY INVESTIGATIONS.

Long before methods of distinguishing the human from the bovine bacillus existed there was evidence that infection from milk was a cause of tuberculosis in the young.

Within a very few years of Koch's discovery of the tubercle bacillus,

*Read before the British Orthopaedic Association, October 20, 1922.

†Dr. A. S. Griffith, Field Laboratories, Milton, Cambs., is carrying on the research. He is particularly anxious to obtain further material from cases previously found infected with atypical strains, from cases of lupus, and tuberculous material removed during laparotomy.

30 per cent. of dairy cattle examined in Edinburgh were found tuberculous, and tubercle bacilli were found in 16 per cent. of samples of milk.

Fraser in 1912,[1] and Mitchell in 1914[2] published papers on the rôle of bovine bacilli in bone and joint and cervical gland tuberculosis of children. Fraser compared bottle fed with breast fed babies and found:

TABLE 1.

	Cases	Bovine	Human	Mixed
Bottle-fed	43	35	3	3
Breast-fed	26	7	19	--

and comparing infants from families of which a member was known to be infected with tuberculosis with those from families without such known infection:

TABLE 2.

	Cases	Bovine	Human
Infants from infected families	21	6	15
Infants from apparently uninfected families	46	43	3

The results of Fraser and Mitchell show an unusually high proportion of "bovine" infection when compared with those obtained more recently by Eastwood, F. Griffith and A. S. Griffith, by their standard methods (shortly to be detailed).

However, the relative proportions of the two types seem to vary a great deal in different parts of the world. "Bovine" tuberculosis seems very rare in Paris and common in London and New York.

MORE RECENT METHODS OF CLASSIFYING TUBERCLE BACILLI.

At Cambridge a systematic series of tests have been applied to various strains of bacilli from cases of surgical tuberculosis by A. S. Griffith, F. Griffith, and Eastwood.[3]

The bacilli were recovered either direct from the specimen (aspiration fluid, sinus discharge, granulation tissue, etc.) or through a guinea pig.

A. CULTURAL TEST. Cultures are raised on egg medium and then tested on bovine serum and glycerine media (serum, agar, potato or broth).

"Human" (1) "Eugonic" on all media.

(2) Wrinkled layers on agar, potato, and broth.
(3) Pigmented on suitable bovine serum.

"Bovine" (1) Dysgonic. Three grades of growths, but best growing bovine strains fall distinctly below the human in luxuriance.
(2) Not pigmented on bovine serum.

B. ANIMAL TEST. Rabbits (inoculated subcutaneously).

"Human" *Virulence low—rabbit never dies within 3 months* from tuberculosis.
Spleen and lymph glands seldom affected, lungs not enlarged, isolated tubercles or tuberculous masses.

"Bovine" *Virulence high—rabbit almost always dies within 10 weeks.*
Generalized tuberculosis.
Spleen and lymph glands generally affected.
Lungs—voluminous, studded throughout with tubercles or confluent tuberculous masses.
Kidneys beset with tubercles and nodules.

A. S. Griffith collected all the cases of human tuberculosis that have been investigated by identical methods in Great Britain and reported. The total number is 1068—of these 395 are cases of bone and joint tuberculosis and the figures are as follows:

TABLE 3.

Cases of Bone and Joint Tuberculosis.

Age period	No. of Cases	Human	Bovine	Atypical	Percentage Bovine
0 - 5	84	57	25	2	29.76
5 - 10	167	121	42	4	25.15
10 - 16	90	77	8	5	8.8
Over 16	54	48	3	3	5.5
All ages	395	303	78	14	19.7

There are two main types—the "standard human" and "standard bovine" and a group of atypical strains. The "bovine" bacillus is responsible for a large share, varying between 25 per cent. to 60 per cent. of bone and joint tuberculosis during childhood; as the age period of the attack advances "bovine" infection becomes less frequent and is rarely met with in bone disease after 20. The "human" bacillus, while taking a considerable share of the responsibility at all ages, covers almost

the whole field in adult life. "Atypical" strains account for a very small number of cases.

The progressive lessening of the proportion of cases from which bacilli giving "bovine" type reactions are obtained would seem to indicate either that increasing age gives increasing resistance to bovine bacilli and that adults are immune, or that the bovine bacilli, which almost always gain access to the body in early childhood, have, in the course of years, lost their bovine characteristics.

Calmette[4] says that there is only one species affecting mammals and that it is adaptation of the bacillus to the human or bovine host that gives rise to the two main varieties with which we are concerned. One naturally jumps to the conclusion that the "atypical" group represents bacilli of bovine origin in process of adaptation to their human environment, and that this group might well be named "transitional." And *yet*

(1) such an adaptation has never been proved experimentally;

(2) all three groups of bacilli conform closely to a standard—from whatever source they are recovered, and at whatever age—

(3) in the few instances where the "atypical" bacillus has been recovered from a case at two periods with a distinct interval (in one case 19 months) the cultural and virulence characteristics at the early and later periods have proved identical.

Although the experimental evidence is as yet entirely negative, I feel that further cultural and virulence tests of "atypical" bacilli should be carried out repeatedly over as lengthy periods in each case as possible. It may perhaps still be possible to recover bacilli from some of the "atypical" cases recorded by Eastwood and Griffith; if so, a record of their present test characters would have great value.

Much clinical interest lies in this possibility of the transition of the infecting strain from "bovine" to "human" type within the period of its sojourn in one human host. Does the "bovine" bacillus, which so constantly penetrates the membranes of the infant's body with cow's milk, and which is so often responsible for bone and joint tuberculosis during childhood, change in character in course of time to the "human" type? And, if so, do these bacilli of human type but bovine origin share with the bacilli derived directly from a human source in the responsibility for all the manifestations of tuberculosis in later life.

In Table 4 A. S. Griffith gives the number of each clinical variety of case investigated and the relative frequency of the two standard types and atypical varieties of tubercle bacillus respectively in each set of cases:

TABLE 4.

Bone or Joint	No. of Cases	Human	Bovine	Atypical
Hip	50	43	6	1
Spine	28	17	8	3
Knee	14	13	1	—
Ankle	5	5	—	—
Multiple	28	22	5	1
Other Bone or Joint	10	7	3	—
Total	135	107	23	5

He emphasizes the constancy of the group characteristics.

"From several of the cases more than one strain of culture has been investigated, and in each case the different strains were found to be identical in cultural characteristics and virulence."

"Two cases in my series had been previously and independently investigated by Eastwood and F. Griffith, one......yielded to each investigation a fully virulent 'bovine' culture. The interval between the taking of the two samples was 9 months. In the other ('atypical') case the cultural and virulence characteristics were, so far as they could be compared, identical—the interval between taking of material being about 19 months."

Griffith says that the "atypical" (or dysgonic human) bacilli are so constant in their biological characteristics as to constitute a distinct variety of tubercle bacillus. They can be readily distinguished by cultural tests from both "human" and "bovine" types[5], and by virulence tests from the "bovine" type.

In another paper evidence is given of the prolonged persistence of the "bovine" characteristics in cases of genito-urinary tuberculosis.[6] One case gave "bovine" cultures in August, 1912, December, 1912, February, 1913, and October, 1913. All were typically bovine and "cultures from the later specimens showed no indication of modification in the 'human' direction." Another case (age 20) gave a "bovine" culture and had a history of tuberculous glands (with scars) *in childhood.*

From the various papers mentioned I have picked out the cases of spinal tuberculosis from the others, noting the age and the type only, in order to arrive at an estimate of the relative age incidence of the disease in the case of the respective infections. In considering these figures it should be realized that the average ages are of relative value only. The research at Cambridge was carried out from material dispatched from a number of sources and mainly came from special hospitals for the treatment of *children* suffering from surgical tuberculosis. All ages are therefore not equally represented.

Of 130 cases of tuberculosis of the spinal column the average ages were:

Human = 11.14 Bovine = 5.8 Atypical = 15.9

In other tables it is shown that the "bovine" bacillus as a cause of bone and joint tuberculosis disappears after the age of 20.

A very interesting and suggestive comparative table is that of 108 cases of cervical gland tuberculosis and 45 of lupus. In this table the proportion of "bovine" infection is very much higher, *viz.:*

TABLE 5.

Age period	108 Cases Cervical Gland. "Bovine"	45 Cases Lupus. "Bovine"
0 - 5	86.6%	63.6%
5 - 10	63.3%	52.6%
10 - 16	33.3%	50.0%
Over 16	25.64%	22.2%
	46.3%	48.9%

and in "scrofuloderma" the figures are similar. But in both these skin conditions the large majority of strains do not give typical virulence test results, 36 out of the 45 strains, both human (18) and bovine (18), showing very marked reduction of virulence.

THE OCCURRENCE OF STRAINS OF THE TUBERCLE BACILLUS OF LOWERED VIRULENCE.

In only 46 of the 1068 cases already quoted do the strains of tubercle bacilli show any clearly marked alteration of virulence. And in 44 out

of the 46 the cultures were derived from cases where the skin was the main lesion. The only non-cutaneous lesions providing a strain of reduced virulence being, (1) a muscular or intermuscular abscess of the thigh from a girl, aged 12, in whom a tuberculous cervical gland yielded a culture of standard virulence, and (2) a cervical tuberculous gland.

TABLE 6.

Data from Tables Giving the 1068 Cases

		Human		Bovine	
	No. of Cases	Typical	Attenuated	Typical	Attenuated
Lupus	45	5	18	4	18
Scrofuloderma	52	28	4	16	4

In lupus 36 out of 45 are attenuated, in scrofuloderma only 8 out of 52.

A. S. Griffith (*Journal of Pathology and Bacteriology*, Vol. xxiii, No. 2, Feb., 1920) discusses this most interesting matter, and states:

"The occurrence of attenuated strains of tubercle bacilli in scrofuloderma is of great interest and importance. Hitherto attenuated strains of tubercle bacilli have been found....only in lupus lesions, a tuberculous cervical gland, and an intermuscular abscess. In lupus, which is caused by tubercle bacilli of human and bovine type in about equal proportions, the great majority of the strains have shown attenuated virulence. The presence of attenuated strains in the lesions of another variety of skin tuberculosis is, therefore, not surprising, and the difference in proportion of attenuated to standard strains in the two diseases is probably related to differences in the situation and duration of the tuberculous lesions. In scrofuloderma the tuberculosis affects primarily the subcutaneous tissues or the deeper layers of the skin and is of relatively short local duration, whereas in lupus the lesions are *more superficial and of greater* chronicity."

The attenuation of tubercle bacilli is apparently then the rule in skin lesions. Is it not possible that there may be some very real relation between this reaction between the skin and the bacilli in lupus and scrofuloderma and the beneficial action of the sun and the wind in treatment? And may not this function be developed and used to a much greater degree?

CONCLUSIONS.

1. The bacilli fall into three groups:
   - Human.
   - Bovine.
   - Atypical (comparatively small but quite distinct).
2. The proportion of cases for which the bovine bacillus is responsible

varies to some extent with regard to the site of lesion; *e.g.*, they play a larger part in gland than in bone and joint tuberculosis, but the variation due to age differences is much more marked; their responsibility is great during the first five years of life and disappears rapidly after the age of 16.

3. The various strains of bacilli in each group give consistently the reactions characteristic of that group. Strains of bacilli giving intermediate reactions are almost unknown.
4. In no instance have bovine or atypical strains when investigated at intervals in the same case shown change of cultural or virulence reactions toward the human. Further investigation at longer intervals is needed.
5. There is no experimental evidence that the atypical group is composed of bacilli whose characteristics are changing from bovine to human type as a result of human environment.
6. Tubercle bacilli of lowered virulence are found exceedingly rarely except in connection with tuberculous lesions involving the skin; on the other hand in cutaneous lesions bacilli of lowered virulence are common, and this is most marked in lupus, a condition where the more superficial layers of the skin are involved over long periods. This is a further reason for our belief that the skin is an organ particularly valuable in the contest between man and the tubercle bacillus. Scarification and innunction, or intradermal inoculation of tuberculin may prove of exceptional benefit in the treatment of all forms of tuberculosis.

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ABNORMALITIES OF THE FIFTH LUMBAR TRANSVERSE PROCESSES ASSOCIATED WITH SCIATIC PAIN.

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INASMUCH as the rôle of malformation of the transverse processes of the fifth lumbar vertebra in causing pain in the low back and legs is attracting so much attention, it would seem to be of interest to present some observations on a series of nine cases, seven of which have been operated upon.

Dr. Z. B. Adams, in 1910, was the first to suggest that these abnormal processes might have a pathological significance in cases of so-called sciatic scoliosis. Since then numerous cases have been reported in the literature, but there is still considerable difference of opinion as to whether the symptoms associated with the abnormal transverse processes are really due to their presence. There is a still greater difference of opinion as to the treatment of the condition.

These abnormalities are frequently found in x-ray examinations of cases in which there are no symptoms that would suggest their presence. On the other hand, they may be found associated with symptoms for which they may account.

These cases nearly all resemble each other rather closely, so that for the purposes of study one case will be given in detail, and the others briefly.

CASE 1. B. H., aged 24 years, married, mother of four children. Entered Cook County Hospital, February 16, 1921.

Complaint: pain in lower back and left leg.

Back pain began five years ago during first pregnancy. It was dull and aching, located in the lower lumbar muscles and upper part of the left hip just outside the sacro-iliac joint. This pain has persisted almost constantly ever since, and was increased during each pregnancy. During her last pregnancy, seventeen months before, she began to have sharp shooting pains down the back of the left thigh and calf. These pains were not constant, but were brought on by walking, stooping, or lying on the right side. Latterly there had been some numbness on the

dorsum of the left foot. At times there was a "crawling" sensation in the same region.

Examination showed a moderate list of the entire spine to the right, with slight flattening of the lumbar curve. There was moderate tenderness over the lower portion of the left lumbar muscle. The spine itself was flexible, but forward bending caused pain in the left hip, localized about two inches outside the sacroiliac joint. The spine could not be brought beyond the vertical to the left. Any attempt to do so caused pain down the back of the left thigh and in the calf. Rotation of the lumbar spine to the left caused the same pain. The muscles of the left thigh and leg felt distinctly more flabby than those of the right, though the measurement was the same. The left peroneal and tibialis anticus muscles were decidedly weaker than the right. Sensory changes were not marked. Light touch and pain were localized well. The temperature sense was normal. Just behind the toes on the dorsum of the foot there was an area where light touch caused formication.

In standing, the weight was habitually carried on the right leg, and the left side of the pelvis sagged. She walked with a slight, left-legged limp. Wassermann test negative.

Stereoscopic x-ray plates showed a large fish-tailed transverse process on the left side with the upper portion definitely in contact with the ilium. The process on the right was normal. No arthritic changes were seen.

February 24, 1921: operation. Transversectomy, left fifth lumbar. Upper portion of process removed. It was definitely impinging on the crest of the ilium. No bursa was found.

The patient had considerable postoperative pain, but no paralysis. She was kept in bed for three weeks, by which time the pain had disappeared, and she was able to walk without a limp. The list of the spine had also cleared up. Postoperative x-ray showed that the process was not completely removed, the lower portion being left. The patient reported recently by letter that she had had no further trouble, and that the backache had not recurred.

Case 2. W. S. Male; age 33 years; laborer.

Complaint: pain in right leg, hip, and low back. Duration, seven months; came on gradually; noticed first in back and hip. Then became worse and ran down back of thigh and calf. Has been unable to work. Pain is increased by motion of spine.

Examination: Marked list of spine to left; cannot be brought to

vertical. Tenderness in right upper buttock and lower lumbar region. Rectal examination negative. Wassermann negative.

Stereoscopic x-ray plates showed long hypertrophied transverse process of right side of fifth lumbar vertebra, in contact with the ilium. April 30, 1921. Operation: transversectomy, right fifth lumbar. The process was found in contact with the ilium, and a very strong, fibrous cord extended from the tip of the process to the inner face of the ilium.

The patient had considerable postoperative shock, and the pain in the leg persisted for about two weeks. Postoperative x-ray showed incomplete removal of the process, the lower portion remaining.

Exercises and occupational therapy were begun at the end of two weeks, and the list of the spine cleared up in about two months. The spinal motions became normal.

The patient reported for observation six months after operation, and was working then without trouble. X-ray taken at that time showed the remaining portion of the process more plainly than the first postoperative x-ray. It may represent a partial regeneration of the process.

CASE 3. A. B., male; age 28 years. Collector.

Complaint: pain in low back, right upper buttock, and back of right thigh and calf. Began in back and buttock about nine months ago. Back was strapped with adhesive plaster, with slight relief. Recently the pain has localized itself in right sciatic region also. This has been severe enough to prevent him from working.

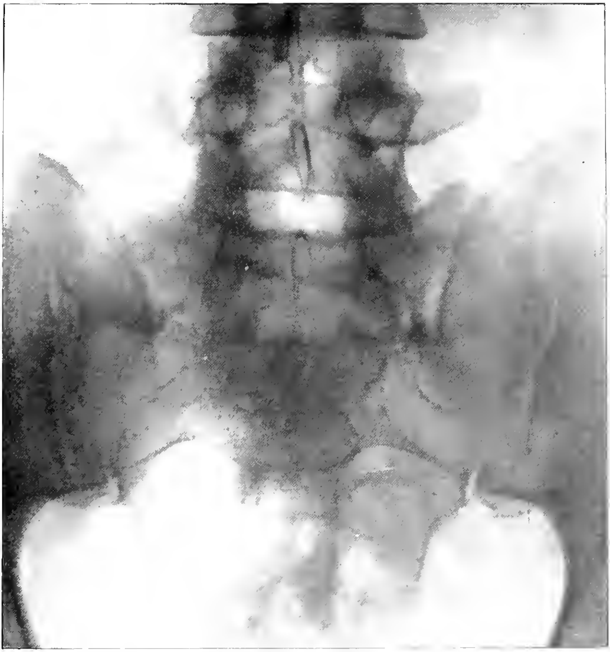
Examination: All motions of lumbosacral region limited, and caused marked pain in right sciatic region. Spine is straight. Lumbar curve slightly flattened. Tenderness about two inches outside the sacroiliac joint on right side.

X-ray showed complete sacralization of both transverse processes of the fifth lumbar vertebra. Patient was kept in bed for three weeks, with no relief.

On November 21, 1921, tonsillectomy was done by Dr. McBride. On December 5, 1921, patient was able to return to work, and has had no further back or sciatic trouble, though his occupation requires much walking, and involves carrying a weight of fifty or sixty pounds most of the day.

CASE 4. J. S. Male; laborer; age, 39 years.

Complaint: Pain in lower back, left upper buttock, and back of left thigh and calf. Duration in back: eight years, with some intervals of relief. In sciatic region for one year constantly.



CASE 3. Complete sacralization of the fifth lumbar transverse processes. Symptoms relieved after tonsillectomy.

Examination showed marked list of the spine to right with flattening of lumbar curve; three-fourths inch atrophy of left thigh. Some weakness of anterior tibial group of muscles. Could not correct position of spine to the vertical. All motions caused pain in the left sciatic region.

Rectal examination, negative. Blood, spinal fluid, and Wassermann negative. X-ray showed elongated, club-shaped transverse process on left side of fifth lumbar vertebra. It was not in contact with ilium as patient lay with spinal column drawn toward the right.

November 6, 1921. Operation: transversectomy, left fifth lumbar. The process was found in contact with the ilium, and a tough fibrous

CASE 4.—Showing the marked list of the spine to the right, with the left transverse process not in contact with the ilium. At operation it was in close contact.

cord extended from its tip to the ilium. The patient had very little postoperative reaction, and the sciatic pain had disappeared by the fifth day, and he was walking a little on the tenth day. He was put on exercises in three weeks, and the lateral curve of the spine disappeared in about six weeks.

He was seen five months afterward and was working as a machinist, and had none of the old trouble.

CASE 5. F. S. Male; negro; laborer; age, 44 years.

Complaint: Pain in left lower back, upper buttock, and back of left thigh and leg. Duration, six years. Onset was very sudden and severe, with pain shooting down the leg from the hip. Had considerable diffi-

CASE 4.
FIG. 1.—Before operation. Maximum voluntary correction of scoliosis.

CASE 4.
FIG. 2.—Two months after operation.

culty in walking at the time. Was in the hospital nine months at that time. Pain in the back has persisted ever since. Pain in the thigh has been constant for several months this time.

Examination: All spinal motions limited. Moderate list to right. Left thigh shows atrophy of one inch; left calf one-half inch. Rectal examination negative. Wassermann negative. X-ray showed large fish-tailed process on the left side of the fifth lumbar vertebra. There was also some osteoarthritic change present.

November 10, 1921. Operation: transversectomy, left fifth lumbar. The process was found in contact with the ilium with a fibrous cord extending from the tip of the process to the ilium.

The patient had very little postoperative trouble. The sciatic pain had disappeared by the eighth day. He was up and walking with a cane in two weeks. Postoperative x-ray showed complete removal of process. The patient was discharged from the hospital January 19, 1922. The motions of the spine had improved somewhat and he was free from pain. The scoliosis still remained, and the weakness of the left leg remained, causing a limp. He has not been seen since.

Case 6. R. B. Salesman; age, 40 years.

Complaint: Pain in right buttock, thigh and leg. Duration, eight months. Began in right foot and gradually worked up the leg, localizing in the low back about a month after its first appearance.

He had been in another hospital for two months previous to entering Cook County Hospital. His tonsils had been removed six weeks before. The hip and sacroiliac joint had been manipulated under ether without benefit.

Examination: Slight list of spine to the left. All motions of lumbosacral joint were limited. There was slight atrophy of right thigh and calf. Some weakness of anterior tibial group of muscles. Rectal examination negative. Wassermann negative. X-ray showed slight superposition of transverse process of fifth lumbar vertebra on the sacrum.

February 13, 1922. Operation: transversectomy, right fifth lumbar. Process in contact with sacrum, and heavy fibrous cord present. Following the operation the patient had severe pain in the right leg, which did not disappear entirely for two weeks.

Postoperative x-ray showed complete removal of process. He was placed on exercises and occupational therapy. Discharged March 14, 1922, walking with cane.

He returned April 25 to report that the pains in the back and legs were all gone and that he was working. The list of the spine had disappeared and the motions of the spine were free.

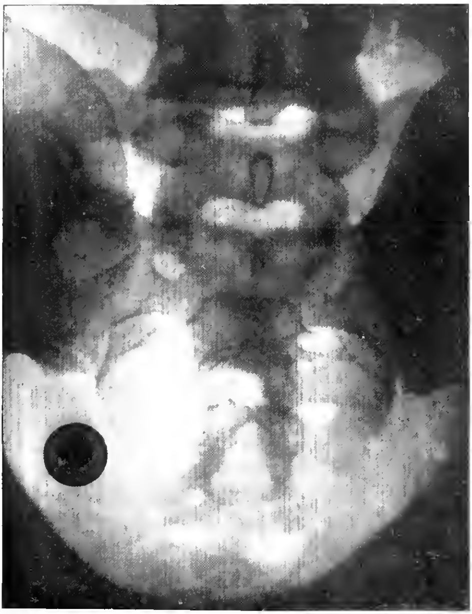
Case 7. J. F. Teamster; age, 47 years.

Complaint: Pain in lower back, both hips, and left thigh and leg. Duration, three months. Began as low back pain on both sides and was slight for three weeks. Then became severe enough to disable him from working and had been constant ever since. Pain in the left thigh and leg is described as "pulling."

Examination: Moderate list of the spine to the left, tenderness in lower lumbar region and upper part of buttocks on both sides. Muscular twitching of left thigh. Spinal motions all limited. Lumbar curve diminished. Rectal examination negative. Wassermann negative. X-ray showed very large butterfly transverse processes on both sides overlapping the ilium.

March 10, 1922. Operation. The left process was removed. The process was found in contact with the ilium and the usual heavy cord was present. The patient had very little post-operative trouble and the sciatic pain had left by the fifth day. The patient got out of bed on the seventh day. Postoperative x-ray showed removal of process.

Patient left the hospital in three weeks with no symptoms.



CASE 8. Sacralization of a sixth lumbar vertebra.

CASE 8. C. J. Negro porter; age, 42 years.

This case presented unusual features. The pain began in the left ankle and outer side of calf and in the left buttock near the cleft of the buttocks. It was so severe that he was unable to walk or move. Gradually became less, but there remained a dull ache with occasional "trickling" sensation down the back of the thigh to the region of the outer malleolus. This had been present about six weeks when patient was first seen.

Examination showed a moderate list of the spine to the right, which could not be voluntarily corrected. Patient could bend to the right well, but any attempt to bend to the left caused sharp pain to start down the left leg to the outer side of the foot and ankle.

CASE 8.
FIG. 1.—Before operation. Showing maximum voluntary correction of scoliosis.

CASE 8.
FIG. 2.—Erect position three weeks after operation.

CASE 8.
FIGS. 3 and 4. Showing lateral motion of spine three weeks after operation.

The x-ray showed six lumbar vertebrae. The fifth vertebra had small transverse processes resembling those of a normal fourth, but the sixth showed very large transverse processes impinging on the ilium at the sides and the sacrum below. Mauclaire has reported a case with similar findings.

June 3, 1922. Operation. Excision of portion of ilium impinged on by the transverse process. No attempt was made to remove the process in this case. The sciatic pain disappeared completely by the fourth day and this patient got out of bed on the sixth day. In two weeks the list of the spine had disappeared. The motions of the spine are normal in extent now, one month after operation.

While it is much too early to venture an opinion as to the outcome of the case, it has certainly showed very marked improvement.

CASE 9. A. S. Age, 47; laborer.

Complaint: Tenderness and pain in right upper buttock. Duration, six weeks. Eighteen years ago had a severe attack of sciatica for which he was treated by rest in bed and leg extension. This attack lasted several months, but he has had no trouble since until the present pain began. Has had several infected teeth removed and trouble is clearing up.

Examination: Motion limited at lumbosacral junction. Tenderness over right sacroiliac line. Rectal examination negative. X-ray showed complete sacralization of transverse processes of fifth lumbar. The right sacroiliac junction is entirely obliterated and there is a dense area of bone in this region. There is a question as to whether this represents an old healed sacroiliac disease or a new growth. The case is of interest largely on account of the attack of sciatica eighteen years ago and the present findings.

The clinical picture in all these cases is that of irritation of the sciatic nerve, combined usually with some deviation of the spine from the vertical. It does not differ materially from the picture presented by arthritis of the lower lumbar spine associated with sciatic pain except that there is less general rigidity of the spine and more localized limitation at the lumbo-sacral junction. The x-ray is the determining factor in the diagnosis, but one plate is not a safe guide. Several should be taken at varying angles or stereoscopically to determine completely the relations of the process to the sacrum and ilium. Furthermore, in cases with a marked list of the spine, the x-ray may not show the process in contact with the ilium, yet at operation they are found in close contact. The

list of the spine is apparently an attempt to draw the process away from the ilium.

The mechanism of the production of the pain is an open question. The several theories are:

First: That it is produced by pressure of the soft parts, *i.e.*, muscle or ligament, between the transverse process and the ilium.

Second: That it is produced by irritation or arthritis of abnormal bursae or joints.

Third: That it is due to strain of the sacroiliac and lumbosacral joints due to the leverage of the transverse process.

Fourth: That it is due to stretching or pressure on the nerves of the lumbosacral plexus.

As to the first and second theories, in none of the seven cases of this series operated on, was there any muscle interposed between the process and the ilium. Nor was a bursa found in any case. In only one case, No. 8, was there anything resembling a joint and there was no gross evidence of arthritis in that.

As to strain of the joints in the lumbosacral region, it is mechanically possible. A transverse process impinging on the ilium would form the short arm of the lever and the spine above the fifth lumbar vertebra the long arm. In spite of the fact that the long arm is somewhat flexible, powerful leverage would be exerted both on the sacroiliac and lumbosacral joints.

So far as pressure on the nerve is concerned, the fifth lumbar nerve, which would be the one affected, passes from the vertebral column at the base and in front of the transverse process, where it would seem to be well out of harm's way so far as pressure by this enlarged process is concerned.

It is possible that a combination of the third and fourth theories will best account for the trouble; that is, that the leverage of the process causes a slight shifting of the entire fifth lumbar vertebra, enough to produce pressure on the nerve at its exit. The symptoms are those of nerve irritation and not those of complete nerve block, so that a very slight shift would be enough to account for it.

The fibrous cord found extending from the tip of the process to the face of the ilium may be of importance in this connection. Fassett also noted this cord in two out of three of his cases. It may be a factor in dragging on the vertebra as leverage is exerted.

The question as to why the trouble comes on usually so late in life is a difficult one to answer. The abnormal processes themselves are a

developmental peculiarity. They may give rise to a potential weakness which some strain transforms into an active pathological process. Bertolotti believes the onset of symptoms has a direct relation to the completion of ossification of the ilia and the fifth lumbar vertebra which occurs between 25 and 30 years. The first case reported by Adams was in a girl 16 years old, and Richards has reported one 13 years of age.

Treatment.—This has run the gamut from radical operation to x-ray treatment, and all forms have successes reported. These successes have done much to confuse the subject. Case No. 3 is the fly in the ointment in the series reported here. Certainly there must have been another element than the sacralization in this case, if any reliance can be placed in the therapeutic test.

As to the results of the radical operative treatment, opinion differs widely. Richards made the statement that no case has been completely cured by operative measures. However, Adams, Fassett, Blanchard and Parker, Magnuson and Shackelton have all reported cases in which relief had been obtained following operative removal of the process.

The operation in the series reported in this paper was amputation of the process in six of the cases. The technic used was somewhat different from that usually described.

The skin incision, about six inches long, was over the posterior portion of the crest of the ilium, which was exposed. The lumbar and gluteal muscles were then stripped subperiosteally from this portion of the crest. A segment of bone, about two inches long and one inch wide, was cut from the ilium and removed. This was done with a double purpose. It made an easier approach to the process and it removed the portion of the ilium impinged upon by the process. The process was then freed from the fibrous cord usually found and removed with an osteotome. Closure was made by suturing the periosteal edges with the muscles and the usual skin closure.

In the last case operated upon, No. 8, the crescent of bone was removed and the process left intact. The case is too recent—one month—to say what the final result will be, but so far it has run the same course as the others; that is, the pains have been relieved and the motion of the spine improved. If the relief is permanent this is certainly a much simpler and easier operation.

None of the cases were put in plaster or braces, and they were gotten out of bed in 10 to 14 days. Back-bending exercises were begun as soon as they could be done with comfort.

Results.—In five of the seven cases the relief from the sciatic pain was rather striking. It disappeared by the fourth or fifth day. In the other two it was slower, lasting 10 to 14 days after the operation.

The scoliosis was slower in disappearing and usually persisted two or three months. In two of the cases, postoperative x-ray showed that the process was not completely removed, yet the symptoms were relieved. In these cases the removal of the portion of the ilium was probably the effective part of the operation.

These cases are all too recent to decide as to the complete permanency of the results, but they are encouraging. However, equally encouraging results have been reported by manipulation under ether and other treatment.

Cases such as No. 3 and No. 9, where there was evidently another factor than the sacralization in producing the sciatic pain, are a sufficient warning against over-enthusiasm.

The question cannot be considered closed as yet.

THE OPERATIVE TREATMENT OF HALLUX VALGUS.

BY DAVID SILVER, M.D., PITTSBURGH.

Hallux valgus, of the common type, is in most cases not a simple deformity, but only one factor in a general distortion of the forefoot. Hence, although the majority of patients presenting this affection merely seek relief from pain, no method of treatment can be considered sufficient which does not have for its final object the correction of this general distortion and the restoration of foot function. This means, therefore, not only that the operative procedure chosen should be, if possible, one which restores the normal anatomic relations, but also, as is so frequently the case in the treatment of deformities, that the operation itself is only one step in treatment.

In the treatment of hallux valgus the essential pathological changes to be considered are the following:

Gross Changes.—The great toe is deflected toward the outer border of the foot and with this is associated a corresponding degree of subluxation of the phalanx on the metatarsal head. The forefoot is spread, the space between the first and the second metatarsal bones increased, and the first metatarsal is rotated on its long axis, the inferior surface of the head turning inward. The four smaller toes are also deflected outward and are usually dorsi-flexed. A prominence is present on the inner side of the great toe-joint. Leaving the enlargement due to actual bunion out of consideration, this is formed partly by the inner portion of the head which has been uncovered through the subluxation, partly by the projection of the prominent inner edge of the inferior portion of the head brought about through the rotation, and usually only to a lesser degree by any actual bone hypertrophy.

Joint Changes.—The internal (mesial) lateral ligament and the entire inner portion of the capsule are stretched, while the external lateral ligament and the external portion of the capsule are correspondingly shortened. Except when joint disease has existed, the articular cartilages present little, if any, gross change.

Changes in Muscle Balance.—The extensor and flexor tendons, together with the sesamoid bones, are displaced to the outer side of the joint, and hence through their bowstring action tend to perpetuate the deformity. That there should be shortening of any appreciable im-

portance in muscles of such length as the long flexor and extensor seems unlikely. The adductors, whose action tends naturally to increase the deformity, have undergone sufficient structural adaptation to the deformed position to prevent the normal degree of abduction. This is no doubt less pronounced in the case of the obliquus hallucis on account of the direction of its fibers and the consequent compensating effect of the spreading of the forefoot. The abductor hallucis, which normally abducts and flexes the great toe and which is the only muscle available to oppose the deforming tendency of all the others, is displaced toward the plantar surface of the joint and hence has lost its abducting power.

To enter into a detailed consideration of the advantages and disadvantages of the various procedures which have been proposed for the correction of this affection is unnecessary. These are well known to those doing this type of work. Let it suffice merely to say that operation should have for its object the correction of pathology and that to mutilate a joint in order to overcome joint deformity seems most unscientific. Viewing the pathological changes from the operative standpoint, it seems evident that it is necessary to remove only the actually hypertrophied bone, and that the real obstacle to the correction of the distortion of the toe lies in the structural shortening of the tissues on the outer side of the joint, while the difficulties of retention are found chiefly in the loss of muscle balance and to a lesser extent in the structural lengthening of the inner capsule. These are the particular points, it seems to me, which have not been given sufficient consideration in previous operative procedures. The following method of operation is proposed, therefore, because (1) it aims at the correction of the various pathological changes and so restores the normal anatomical relations, (2) it leaves the articular surfaces unimpaired and hence gives rise to no risk of limitation of toe flexion and extension, and (3) it interferes in no way with the subsequent performance of any other procedure in the rare event of the recurrence of the deformity. Most of the details of the operation have been long in use and hence no originality is claimed, except possibly for the method of treating the internal and the external portions of the capsule and the definite attempt to restore muscle balance.

The Operative Technic.—a. The usual curved incision with the convexity downward is made.

b. After the fibrous capsule has been exposed by dissection of the skin flap and the bursa removed, if indicated, a Y-shaped incision is made through it (See Fig. 1A) so as to form three flaps, a distal flap whose base is attached to the phalanx, and dorsal and plantar flaps; anteriorly the incision should be carried well forward upon the phalanx,

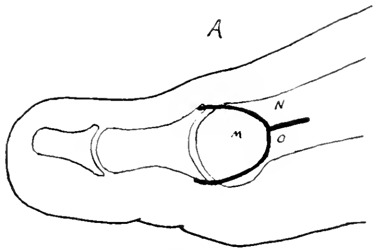
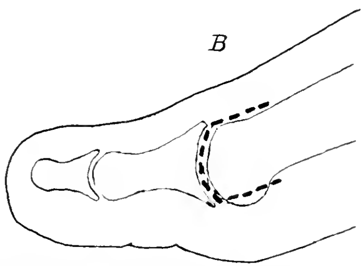
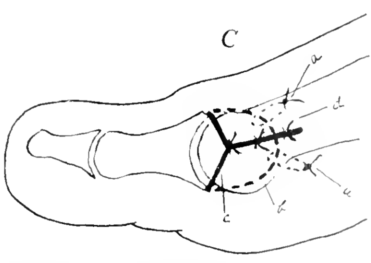


FIG. 1.

A. Position of Y-shaped incision through the internal portion of the capsule shown by the heavy line. m=distal flap. n=dorsal flap. o=plantar flap.



B. Position of incision through the external portion of the capsule shown by the interrupted line.



C. Method of suture of the distal, dorsal and plantar flaps. a=mattress suture. b=distal flap, drawn back beneath the dorsal and the plantar flaps, shown by interrupted line. c=position of dorsal and plantar flaps, when sutured, shown by heavy line. d=interrupted sutures through dorsal and plantar flaps.

but it is not wise to go too far posteriorly, as it is necessary that the posterior attachment of the distal and plantar flaps to the metatarsal be unimpaired. The distal flap, about one-half to five-eighths of an inch long, and as broad at its base as the side of the phalanx, is carefully freed of all areolar tissue on both its outer and its inner surfaces; it is to serve for the reconstruction of the internal lateral ligament. The dorsal and the plantar flaps are dissected back so as to sufficiently expose the metatarsal head and inferiorly the tendon of the abductor hallucis.

c. The great toe being then adducted, a flat chisel is placed against the anterior edge of the inner portion of the head and a thin layer of the cortex, together with the periosteum and any exostoses that may be present, is removed, thus leaving a smooth surface of denuded bone. None of the articular surface is removed, only a little of the cartilage which extends over the side of the head being cut away; the edge must not, however, be left sharp, but should be rounded. Care must be taken not to leave any periosteal shreds.

d. The next step is the formation of an external capsular flap with its base attached posteriorly to the metatarsal (See Fig. 1B). The distal and the dorsal and plantar flaps are now retracted and the great toe held in slight dorsal flexion with traction to put the capsule under tension. A strong tenotome is then inserted between the superior portion of the capsule and the head, and a superior longitudinal incision made from the top of the phalanx backward to the posterior limits of the capsule. Then with the toe slightly plantar flexed, an inferior longitudinal incision, as close to the flexor tendon as possible, is made in a similar manner. Finally, with the toe adducted and under sufficient traction to separate the joint surfaces, a vertical incision is made through the capsule close to the base of the phalanx uniting the two longitudinal incisions and thus completing the formation of the flap. In making this vertical incision, the attachment of the tendons of the adductor and obliquus hallucis, which is toward the plantar surface of the base, is divided. If these incisions have been properly made, all resistance will be overcome and it will then be possible to correct the subluxation of the phalanx on the metatarsal head, to bring the toe into extreme overcorrection (45° abduction), and to displace the flexor and extensor tendons, together with the sesamoid bones, to the inner side of the joint.

e. The subluxation having first been corrected, the great toe is then held in extreme overcorrection (45° abduction), and the distal flap, which is to form the new internal lateral ligament, is sutured in position with two mattress sutures of chromic catgut (see Fig. 1C). The first suture is passed through the dorsal flap well back toward its posterior

end and through the upper corner of the distal flap, while the second suture is similarly placed between the posterior end of the plantar flap and the lower corner of the distal flap; when the two sutures are tied, the distal flap is drawn strongly backward beneath the dorsal and plantar flaps, thus holding the toes firmly in the overcorrected position, and its roughened under surface is spread out over the denuded bone area on the inner portion of the head. The dorsal and plantar flaps are then drawn strongly inward and sutured with interrupted sutures of chromic catgut as far forward as possible, overlapping the distal flap. In passing these sutures through the plantar flap, the abductor tendon should be included. This brings the flexor and extensor tendons, together with the sesamoids, toward the inner side of the joint and pulls the abductor hallucis up into its normal position, thus completing the restoration of the muscle balance.

f. The skin is closed with waxed silk, a cotton compression dressing (English method) is applied to prevent bleeding and swelling, and an aluminum splint added to maintain extreme abduction.

Subsequent Treatment.—Too great emphasis cannot be laid on the necessity of following a consistent plan of after-treatment until normal foot function is reëstablished. This is sufficient excuse for outlining briefly the measures indicated even although most of them have already been covered in the articles of others. Attention to the remaining deformity in the forefoot must be begun as early as possible. In a few days, after soreness has disappeared, a bias flannel bandage is substituted for the cotton dressing, the splint being retained. This bandage is applied so as to cover the entire foot except the great toe, the turns being made first from within outward over the dorsum so as to overcome the spreading of the anterior arch, and then from behind the heel obliquely forward over the small toes so as to force them downward and inward; it should be re-applied daily, special attention being paid to securing and maintaining overcorrection of the deformity of the four smaller toes, and should be worn constantly until the foot is ready for the shoe. The skin sutures are removed in five to seven days and a collodion dressing applied. Walking on the outer borders of the feet is begun in a week. Not only does the use of the foot in this position strengthen the arches, but also, since all the toes are held in the overcorrected position by the dressing, it is a valuable aid in the restoration of muscle balance.

In from three to four weeks, depending on the severity of the case and the manner in which overcorrection of the great toe is maintained, the foot may be made ready for the new shoe. The splint is removed and adhesive strapping used to relieve the new ligament of part of the

strain to which it is to be subjected. For this strapping four to six pieces of adhesive plaster, a half inch wide and about eight inches long, are required. With the great toe held in the overcorrected position, the first strip is placed against its outer side near the tip of the toe, carried backward and inward over the top of the toe to the center of the great toe-joint and then obliquely backward upon the sole, being drawn tight while the skin is pulled strongly forward; the second strip starts near the same point but passes under the toe to the center of the great toe joint and then obliquely backward over the dorsum of the foot; the remaining strips are applied in a similar manner, overlapping the first two. The correction of the spreading of the anterior arch which has been secured by the bandaging is retained by the use of an anterior leather lacing. In severe cases it may be even advisable to supplement this for a time with adhesive strapping, since the normal position of the great toe cannot be long maintained if the forefoot be allowed to spread. In some cases, of course, some other form of anterior support may be required. A stocking with a digit for the great toe (Japanese sock), which is made by altering an ordinary stocking, is used during the early weeks. Since the foot is usually slightly larger than normal and so, since it is not wise to have the new shoe fitted at once, an old shoe of fair shape may be taken and the inner half of the toe cut out as far back as, but no farther than, the center of the great toe-joint; this permits the great toe to retain its abducted position. In a few days swelling is sufficiently reduced to permit the new shoe of the in-flare type to be fitted.

The bandage, and even the splint if thought necessary, should be reapplied for the first few nights. The adhesive strapping should be gotten rid of as soon as possible to permit the use of hot and cold douching. There seems to be no need of paying any attention to toe flexion and extension, but passive abduction to prevent recontraction of the external portion of the capsule should be practised by the patient for a considerable period.

A normal, or approximately normal, foot form having been secured, attention must then be directed to the restoration of foot function, the chief safeguard against relapse and the final object of treatment. Only when the proper use of the foot in both standing and walking becomes instinctive can the patient be discharged with safety, and this result cannot be secured by the performance of a few exercises and by taking a few steps in the proper manner once or twice a day. A short course of intensive training is required. With individual attention by the surgeon and reasonable application on the part of the patient, anyone who does

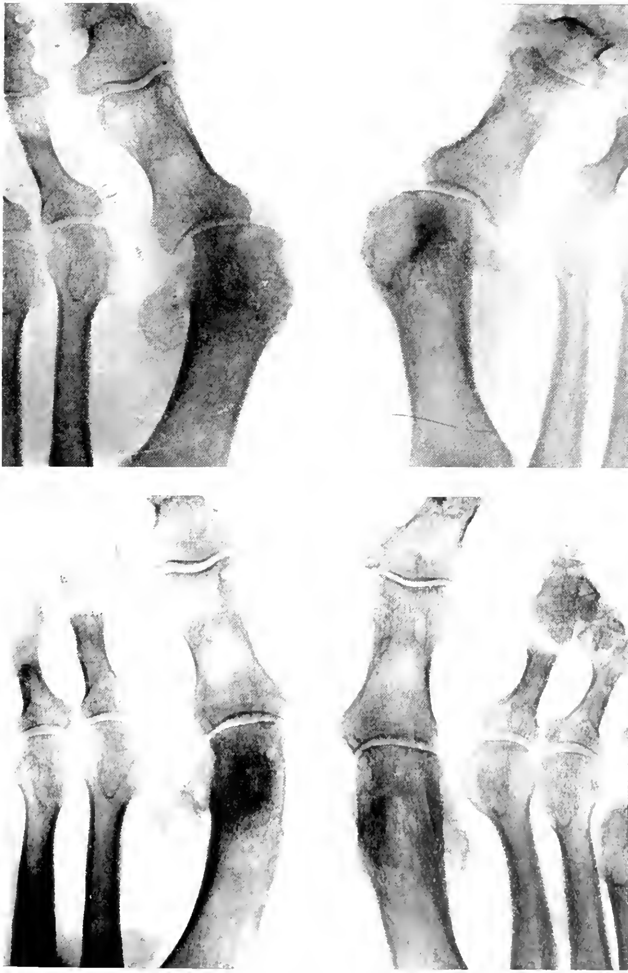


FIG. 2.—Radiograms of R. F. N. before operation (above) on January 27, 1921, and after operation (below) on January 5, 1923. This man, a ward patient,

did not report after operation as directed. When seen two years later, the left foot presented an excellent clinical result, while the right showed a relapse of ten or fifteen degrees with some spreading of the forefoot. Correction of this spreading by an anterior lacing of leather gave a very satisfactory clinical result. The radiogram shows, however, that the correction of all the elements of the deformity has not been attained, the sesamoids of the right foot being still displaced outward, while those on the left are not exactly in position. This explains the relapse and makes the final result less certain. This was one of the earliest cases and only the vertical incision was made through the external portion of the capsule, while it is now recognized that the addition of the longitudinal incisions, thus forming a flap, is required to secure proper mobilization of the sesamoids.

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not present organic foot change can readily acquire a sufficiently normal function to meet the demands of everyday life.

Clinical Report.—The first operation by this method was performed November 27, 1920. Since then 49 such operations on 31 patients have been performed in the Department of Orthopaedic Surgery of the Allegheny General Hospital by Dr. Paul B. Steele and myself. The series includes cases of all degrees of severity but none in which actual joint disease has existed. The oldest patient was 66 years of age. One was a reoperation for relapse following partial resection of the head of the metatarsal in other hands; all others were primary operations. While, unfortunately, it has not been possible to secure a final report on every case at this time, all have been followed from several months to two years after operation. A partial relapse occurred in one toe, in two cases, both bilateral, the first following the wearing of a too short shoe soon after shoe wearing was begun, and the second owing to failure to correct the displacement of the sesamoids (see Fig. 2). In no other case is relapse known to have taken place. In two cases a moderate hallux varus occurred, persisting in one for several weeks and in the other for several months, thus demonstrating the positive retentive action of the method of treating the internal portion of the capsule. All the other cases presented straight and flexible great toes when last seen. Those which it has been possible to follow for the longest periods, six months to two years, continue to present toes which may be justly classed as normal. Although my experience with the various other methods of operation for hallux valgus has been very satisfactory, I have no hesitation in saying that the results obtained by this method have been decidedly better both as regards form and function. The operation is applicable to any case, whatever the age or degree of severity, in which the articular surfaces do not present gross change, but it is particularly indicated in younger subjects, in whom a complete restoration of function should be sought. It should not be performed, however, unless both surgeon and patient are willling to continue the after-treatment until the accompanying deformity of the forefoot has been overcome.

AN OPERATION FOR THE RELIEF OF FLEXION-CONTRACTURE IN THE FOREARM.*

BY C. MAX PAGE, M.S., F.R.C.S., LONDON.

Flexion-contracture in the forearm results from several distinct conditions. The outlook as regards the ultimate function of the hand affected varies considerably in the different types. In civil practice the commonest cause is, perhaps, ischemic paralysis; a flexion-contracture also occurs in association with monoplegia and paraplegias. Another type which has become relatively common since the war is associated with section of the ulnar or median nerves; in these latter conditions the contraction of the flexor tendons is superimposed upon the deformity produced by paralysis of the lumbrical muscles.

The first step directed to the restoration of the function of the hand in all instances of the condition is the full correction of the contracture; this can usually be effected by properly applied methods of splintage. There remain, however, a certain number of cases in which, either from lack of early treatment or on account of an obstinate tendency to recurrence, this method, however patiently carried out, fails. Under such circumstances, some operative procedure becomes justifiable. The methods which have hitherto been put forward are, as far as I know, two: namely, either the shortening of both bones of the forearm, or the elongation of the individual tendons which have become shortened. Neither procedure is free from drawbacks, nor are the results, so far as they have come under my observation, very satisfactory.

As an alternative to these operations I have carried out in six cases a muscle-sliding operation which appears to me to offer a better hope of success. The immediate results are certainly very good. I have, as yet, no evidence as to the late outcome. The causes of the contracture in these six cases were as follows:

Ulnar nerve palsy	3
Ischemic paralysis	1
Monoplegia	1
Hemiplegia	1

The technic of the operation is as follows: A skin incision is made extending from three inches above the inner condyle of the humerus to about the junction of the middle and lower third of the forearm. The cut commences above on the line of the ulnar nerve and passes down the

*Read before the British Orthopaedic Association, October 20, 1922.

back of the forearm just to the ulnar side of the subcutaneous border of that bone. This incision, with suitable undercutting, affords a full view of the operation area. The ulnar nerve is first isolated at the level of the elbow and transposed to the front of the joint, where it will be out of harm's way during the ensuing procedure. The attachments of the whole flexor group of the forearm are next systematically detached from their origin, the supra-condylar ridge is cleared and the common tendon of origin of the flexors is cut close to the internal condyle and stripped away from the lateral ligament (the elbow joint is usually opened at this stage). The aponeurosis on the ulnar side of the subcutaneous aspect of the ulna is then cut through in its whole length close to the bone. The muscle mass so loosened is raised from the surface of the bone with a raspatory, any definite tendinous origins below the coronoid process of the ulna are divided with the knife, the insertion of the brachialis anticus being fully exposed. If the flexor longus pollicis is contracted the process of muscle-stripping is carried across the interosseous membrane so that the attachment of the thumb flexor to the front of the radius can also be raised.

Lastly, the bicipital fascia is cut through if it appears to offer any opposition to the descent of the muscle group. If care is taken to keep close to the bone during these procedures no important vessels are divided and no damage can be done to any nerve except the anterior interosseous and the terminal part of the internal cutaneous.

The separation of the muscles and of any tight fascia is carried out to such an extent that nearly full correction of the contracture, apart from phalangeal joint deformities, is possible at once. The whole muscle group will be made to descend an *inch* or more from its origin. It may be noted that the correction of the contracture usually appears to be more complete a week or two after operation.

After suture of the skin the hand is put up in the corrected position on a metal splint; this is replaced by a properly fitting plaster mould in a few days' time.

Voluntary control of the mobilized muscles is lost or becomes very weak for a few days after operation and is then gradually recovered. The plaster mould is worn for most of the day during the period of muscle re-education so as to enable the extensor muscles to recover their tone and become effective opponents.

I need not emphasize the point that this procedure is but the first stage towards the restoration of the use of the hand. Careful splintage and the usual physiotherapeutic measures must be employed in order to complete the cure.

CONCERNING THE DIAGNOSIS OF LESIONS OF THE LATERAL PROCESS OF THE FIFTH LUMBAR VERTEBRA AND OF ITS REMOVAL.

BY J. TORRANCE RUGH, M.D., PHILADELPHIA.

Since Goldthwait first called attention to the importance of congenital anomalies in the lower lumbar portion of the spine as factors in back and leg pains, orthopaedic surgeons have been watching and studying intimately this portion of the body, in order to determine more accurately the actual relation between anomalies and obscure symptoms. Among these anomalies, changes in the lateral process of the fifth lumbar vertebra have received a great deal of attention, and many different forms and conditions have been described. It is not the purpose of the writer to take up these malformations in detail, but rather to call attention to a fairly common error in the diagnosis of pressure, overlapping, or a distinct articulation between the end of the lateral process of the fifth lumbar and the crest of the ilium or the upper part of the sacrum. One frequently sees x-ray pictures of this part, which appear to show contact between the lateral process and the neighboring parts. These are made in a direct antero-posterior plane and if the process is a little longer than normal, it will appear to be in contact with the ilium, while in reality, it lies anterior to this part, and may be separated by from one-quarter to one-half an inch. If stereoscopic plates are made, the relations of the two portions will be evident, but as the pictures are ordinarily taken, there is a large margin of error possible. A study of this part by direct plates other than stereoscopic, can be made only by taking them in five different directions. These are:

1. Antero-posteriorly,
2. Obliquely from above downward.
3. Obliquely from below upward,
4. Obliquely from the right side,
5. Obliquely from the left side.

A study of plates thus made will enable one to determine accurately the relation between the lateral process and the crest of the ilium or the top of the sacrum, and a diagnosis of pressure or contact between these two parts should not be made until such a study has been completed.

Another point of interest and value gained from the x-ray plate and which has a direct bearing upon the operative procedure, is the shape of the pelvis. The x-ray plates will show clearly the type of pelvis belonging to the individual and one may know quite accurately before operation, whether much or little difficulty will be encountered in the removal of the process or in the relief of pressure. If a line be drawn across the back between the iliac crests, the lateral processes of the fifth lumbar vertebra will be found slightly below it and the best approach to them is along the posterior curve of the crest of the ilium, rather than next to the spinous processes. If the patient possesses the *male* type of pelvis, in which the ascending curve is almost perpendicular and parallel to the spinous processes, the space between the posterior border of the ilium and the spinous process will be found very narrow, while if the pelvis is of the *female* type, the ascending curve rapidly receding from the spine and flaring more posteriorly, there will be found more room for operative procedure. The removal of the outer end of the process in the case where the ilium runs high and close to the spine, proves a difficult operation and it can be accomplished only through the sense of touch in the bottom of a wound from 2 to 2½ inches in depth. A number of operators have injured the communicating branch between the last lumbar and the first sacral plexus of nerves, where it runs directly in front of the lateral process, and have caused a paralysis in the leg. When one is forced to work by the sense of touch in the depths of a wound, the danger of injuring this nerve and causing paralysis of some of the structures in the lower extremities is an actual one. There are two means of avoiding this, however, the first of which is to be content with the removal of the end of the entire process or of even the outer half. This will be found entirely feasible and very satisfactory as to results, though, of course, must usually be done by the sense of touch. The other method of avoiding the nerve is by the removal of a piece of bone from the border of the ilium opposite the lateral process, thus relieving the pressure between the two parts. This is not difficult and likewise proves satisfactory in its results. If one is familiar with the osteotome and mallet, the separation of the lateral process is fairly easy, but otherwise its removal must be accomplished by forceps and curette, and care must be taken to push the periosteum away from the anterior surface of the process before attempting its extraction.

FRACTURE OF THE NECK OF THE FEMUR WITHOUT SHORTENING.

BY HENRY LING TAYLOR, M.D., NEW YORK, N. Y.

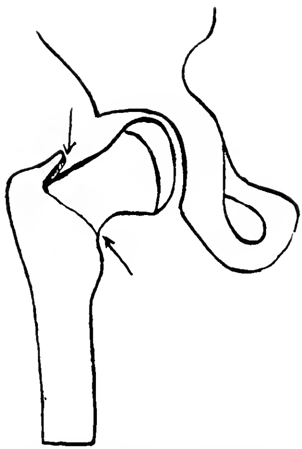
In the clinic of the Hospital for the Ruptured and Crippled, New York, and presumably in most large bone clinics, it is not very uncommon for patients with recent fractures of the neck of the femur, who show no shortening or but a trivial one, to apply for treatment. A considerable number of these patients are able to walk at once with little or no assistance, and in nearly all of them the true diagnosis has not been made. They complain of pain about the hip, groin, or thigh, and of varying amounts of disability. There is usually considerable lameness and there may be more or less limitation of motion; there is usually some persistent eversion, but many of the classic symptoms of fracture of the neck of the femur are absent.

These cases are of several types:

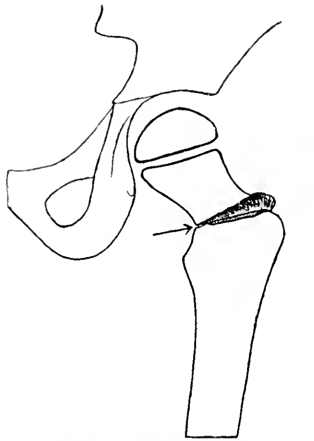
1. Fractures of the neck of the femur in young children.*
2. Epiphyseal fractures in adolescents.
3. Various types of impacted fractures, one of which is the type with vertical displacement of the shaft downward with a coxa valga deformity, instead of upward.
4. There are, besides, various minor fractures and injuries in the neighborhood of the hip, causing pain and disability, which may be mistaken for fractures of the neck, where an x-ray plate is not taken. Most of them show no shortening.

1. It is not generally known that fractures of the neck of the femur are not very rare in young children of five or six or even younger. I am not now speaking of epiphyseal separations in adolescents, of which mention will be made further on, but of true fractures of the neck, which nearly always take place in young children at or near the base of the neck, and which I have called hinge fractures of the neck, since the periosteum on the lower side of the neck often holds, and if there is separation, it occurs as a V-shaped opening, base up, from angular depression of the neck, or rather forcing up of the shaft; there is seldom displacement *en bloc*. If these children are brought for treatment with-

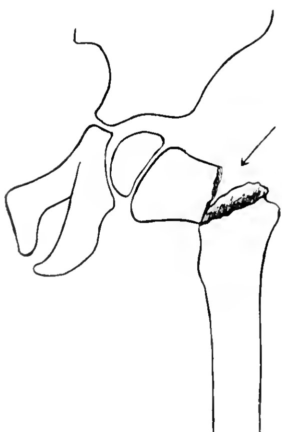
*See paper by the writer in N. Y. State Journal of Medicine, November, 1917.



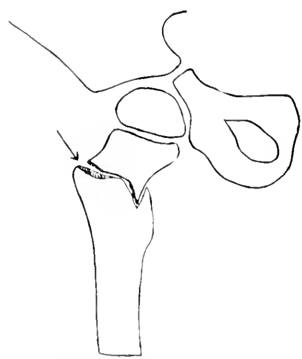
I. Boy; age, 8 years. No treatment. No shortening. Five months after fall.



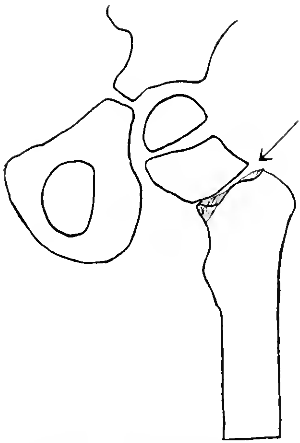
II. Girl; age, 5 years. Right hip. Legs equal. One week after injury.



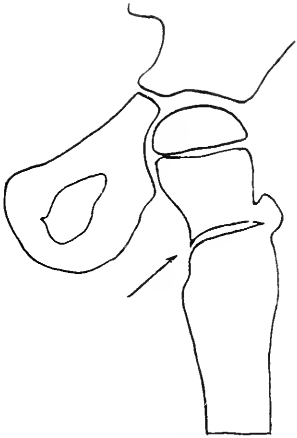
III. Girl; age, 4 years. Right hinge fracture; one-quarter inch shortening.



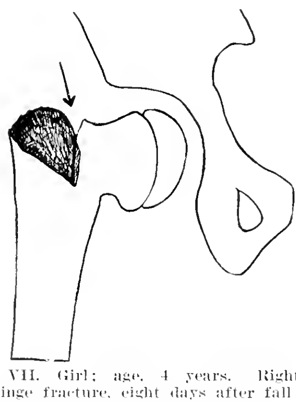
IV. Boy; age, 4 years. Left hinge fracture; one-quarter inch shortening.



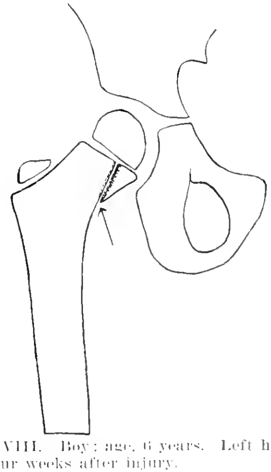
V. Boy; age, 3 years. Hinge fracture; two weeks after fall.



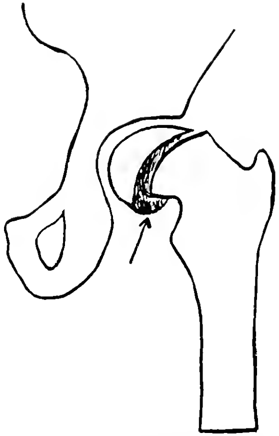
VI. Boy; age, 6 years. Fracture at base; one week after injury.



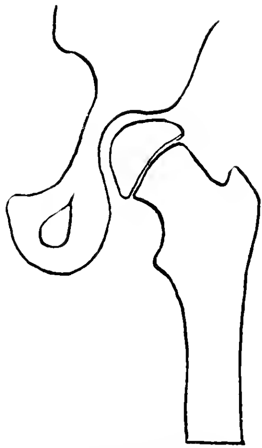
VII. Girl; age, 4 years. Right hinge fracture, eight days after fall; one-quarter inch shortening.



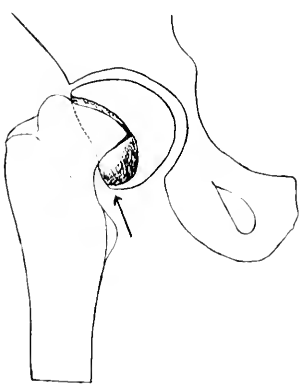
VIII. Boy; age, 6 years. Left hip; four weeks after injury.



IX. a. June 22, 1921. Boy; age, 13 years. Right epiphysis slipping. No injury known.

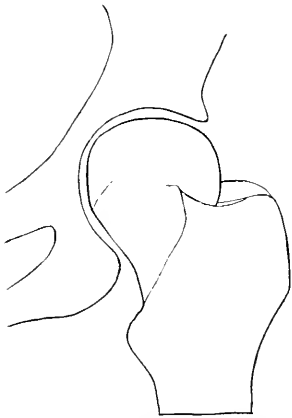


IX. b. Same case, Nov. 22, 1921.



X. a. Girl; age, 13 years. Fracture of left epiphysis. Dec. 6, 1916.

X. b. Same patient, Feb. 1, 1917.



XI. Woman; age, 40 years. Impacted fracture, upward displacement. One year after fall.

out being allowed to walk, there is often no displacement, and consequently no shortening, but if an angular displacement has been allowed to occur, there may be caused a coxa vara and shortening. These cases are particularly appropriate for the abduction treatment.

2. Epiphyseal fracture in adolescents from 12 to 16 is not uncommon and is of two types, traumatic and spontaneous. The first occurs suddenly after an injury, or it may be after repeated injuries. If seen early, it may be replaced by forced abduction under strong traction. The second type is a spontaneous sliding of the epiphysis, which may take place gradually and without a fall or other injury in rapidly growing youths; apparently many of them have an endocrine disturbance, and they are prone to flat feet, knock knees, round back, coxa vara and other static deformities. The epiphyseal fracture may be bilateral. The disability at first may be slight, and the shortening slight or absent in either type of case.

3. Impacted fractures. In some of these, the impaction takes place at the expense of the superior and posterior surfaces of the neck, with limitation of adduction and internal rotation and a tendency to coxa valga.

Impacted fracture right femoral neck. Woman, age 40; seen March, 1915.

Thirteen months before, slipped and fell on street, with right leg doubled under her. Intense pain in hip, but no swelling, mark or bruise. In bed a week; began to go out in three weeks. Consulted several physicians, but no diagnosis was ever given. Now walks with a cane and marked limp; severe pain when walking.

Examination shows fixed eversion, 60° antero-posterior motion; rotation and lateral motion much limited. There is one-quarter inch of shortening; patient cannot lift foot from table when lying.

Roentgen plate shows fracture, middle of neck, apparently impacted; distal fragment rotated outward; tendency to coxa valga.

There are other cases of impaction where the fracture of the base of the femoral neck sometimes includes the adjacent trochanter in such a manner that there is little tendency to spontaneous displacement, though the fragments may be rather easily separated, and walking should be prohibited. I propose for these fractures the name of locked fractures at the base of the femoral neck. If there is no displacement there is, of course, no shortening. Enough has been said to show that fracture of the femoral neck cannot be excluded from the persistence of the ability to walk and the absence of shortening.

Besides the conditions above described, there occur in adults trochanteric fractures—evulsions of the lesser trochanter; cracks or incomplete fractures of the femoral neck; evulsion of a button of bone from the trochanteric fossa; all causing pain and disability in the vicinity of the hip.

Last summer, I saw a lady of 79, of frail physique, who made a misstep and fell heavily on the right buttock; she could walk a few steps, but had pain below the groin. The x-ray revealed a complete fracture at the junction of the pubes and ischium without displacement. She made a good recovery under rest in bed. I owe the privilege of seeing this case and her plates to her physician, Dr. Dreisbach of Dansville, N. Y. Dr. Dreisbach also showed the plates of a man in the twenties who showed an identical lesion, the result of being pinched between car buffers.

OBTURATOR DISLOCATIONS.*

BY JAMES T. WATKINS, M.D., SAN FRANCISCO.

SINCE it is probable the reading of my paper cannot be finished in the time allotted me, I shall, for the sake of the discussion, summarize it at once.

In this paper, which is based upon dissections, the reports of findings in 17 and my own findings in one obturator dislocation, I shall attempt to show that in old obturator dislocations—

1—The hindrance to reposition always present is (a) the constriction about the femoral neck caused by the rent through which the head emerged from the capsule; (b) the hindrance caused by the adventitious capsule which has developed about the head in its new location, and (c) the shrinkage which has taken place in the tense, inelastic fascia lata, the muscles which insert into it, and the gluteus medius.

2—I shall point out that while the pelvi-trochanteric muscles are *never* injured in an obturator dislocation, the act of transforming the latter into the iliac type inevitably produces rupture of the quadratus femoris, and usually of other muscles of this group as well, and may cause irreparable damage to the sciatic nerve. My conclusion is, therefore, that this manual transformation should *never* be attempted.

If you can't get the head back otherwise, you had better do a frank excision, and let it go at that.

3—I shall report a case of nearly three months' duration where, by means of a five-inch longitudinal incision beginning just internal to and below the anterior superior iliac spine and paralleling the inner border of the sartorius, I was able to open the capsule in its upper part, inspect the socket and, proceeding from within outward, to cut the restricting bands already referred to. Then, by carrying a transverse incision three or four inches outward from the lower end of the first incision, I was able to divide the fascia lata transversely. When these maneuvers had been carried out, the reduction of the dislocation all but made itself.

*Read at the meeting of the American Orthopedic Association, held at Washington, D. C., May 1-3, 1922.

FIG. I.—Before operation.

FIG. II.—Before operation.

FIG. III.—Before operation.

FIG. IV.—Before operation.

4—I shall suggest immobilization in flexion and adduction a few days after operation, to be followed by full extension, and then back again to full flexion (just as one does with excisions of the wrist or elbow). In this way I should hope to avoid the ankylosis which is the most common result of open reductions, and which I think to be due to periarticular trauma—myositis ossificans.

In reviewing the literature for this paper, records of 81 old dislocations were found. Some had been reported exactly and in detail, others very sketchily. The material was obtained from the Lane Library, which is said to be the duplicate of the library of the New York Academy of Medicine. However, while the review was fairly broad, it was not exhaustive. No modern French references were found, nor were the writings of the Italians, who are said to speak highly of the work of Fiorani. It is regretted that a description of his method could not be obtained.

To the 81 old dislocations referred to must be added four which have been observed by the writer. Of the 81 luxations, 17 were of the obturator variety. Of the writer's four, one was an obturator luxation.

In attacking the 81 dislocations, six different incisions were employed. They will be analyzed later. Operators used identical incisions with either iliac or obturator dislocations. To these six incisions must be added a seventh used by the writer.

A majority of the obturator dislocations were transformed manually into iliac dislocations, and then operated upon as iliac dislocations. For a very large majority of all dislocations the posterior incision from the trochanter to the posterior superior iliac spine (Langenbeck), posterior inferior spine (Dollinger), was employed.

In attempting to solve the problem of the 18 obturator dislocations, operators were constrained to do six resections. In one case an osteotomy was performed. Twice reduction was accomplished only after the inner wall of the socket had been cut away. Of the 9 which were reduced, one child recovered practically complete function. Two adults recovered partial motion. The remaining 8 became ankylosed. There were three deaths. A majority of the repositions occurred after complete muscular denudation (*Skeletierung*) of the upper end of the femur.

If the pelvis be sawn across in such a way that the section is made through pubis, iliac bones, and sacrum, it will present roughly the appearance of a quadrilateral compressed a little from before backward, with the weight-bearing portions of the hip sockets placed at either lateral angle.

FIG. V.—After operation.

FIG. VI.—After operation.

FIG. VII.—After operation.

When the pelvis is observed as it appears in the normally erect individual, that is, with the sacral promontory directly above the symphysis pubis, it is noted that the planes in which the sides of this quadrilateral lie take a direction downward and inward and upward and backward, meeting each other at approximately right angles in a line drawn from the anterior superior spine to the back of the ischial tuberosity. It is further noted that the socket is deepest and strongest in its upper part where it partially covers the spherical femoral head, and that the bony walls of the socket fade away to nothing as they approach its most dependent portion.

Traumatic dislocations of the femoral head uncomplicated by fracture must then primarily follow two types,—downward and inward or backward and upward. Allis calls them outward and inward; but he always thinks and speaks of his man as lying on his back, and dislocations do not occur to men who are lying on the back. The bony socket is deepened by the cotyloid ligament. Allis aptly calls it the sucker ligament. Except in the extremes of motion the stability of the joint is not dependent upon the capsule *per se*, but upon atmospheric pressure and the normal tone of the muscles, some of which insert into the capsule.

The ligamentum teres has no mechanical significance. The capsule is a loose tube which extends from the rim of the socket, where it is strongest and thickest, to the base of the femoral neck. It checks excessive motion, offers an attachment for muscles and affords a base of support to the synovial membrane. The ilio-femoral ligament is the anterior portion of the capsule. It may be thicker than the Achilles tendon. It arises from below the anterior inferior spine and attaches to the intertrochanteric line and presents an outer and an inner fasciculus, the interval between them being so thin as to be translucent.

The pubo- or pectineo-femoral ligament is a shelving band of fibers which arises from the space between the pectineal line and the pubic spine, from which it passes out to blend with the capsule. It forms the floor for the femoral vessels, from which it is separated by the pectineus muscle. In the so-called obturator variety of dislocation downward, this ligament is uninjured. In the pubic variant of downward dislocation, it *may* be torn. Even this is unusual, and probably explains the immunity of the great vessels to injury in the vast majority of cases.

The ischio-femoral ligament arises from the side of the ischium where this bone meets the ilium and passes outward and downward to attach to the posterior intertrochanteric line. It sends one fasciculus or arm to the digital fossa and another to the base of the oblique line. Between these fasciculi is a sort of fascial web which supports the synovial mem-

FIG. 1.

brane and attaches by loose connective tissue to the middle of the back of the femoral neck.

This structure may also escape damage in the type of dislocation under consideration. But if the usual procedure be followed and before reduction the obturator be transformed into an iliac dislocation, the ischio-femoral ligament must inevitably be destroyed and cicatrization result, most detrimental to ultimate function.

The Vessels.

In neither the downward nor the upward type of dislocation, if uncomplicated, are the great vessels jeopardized, but, as will appear later in this article, their relation to the femoral head (really the femoral neck) must constantly be borne in mind in attempting open operations for the relief of obturator dislocations. The same observation applies, with added force, to pubic dislocations.

The Fascia Lata.

That portion of the fascia lata which is pertinent to this discussion arises from the outer lip of the iliac crest. The anterior two-thirds of the gluteus maximus passes downward and forward to insert into it, while the tensor fascia passes downward and backward, also to insert into it. The fascia then passes over the great trochanter from which it is separated by a large bursa, and thence down the thigh as the ilio-tibial band to the outer tuberosity of the tibia. This ilio-tibial band is to all intents and purposes, a tendon. Because of these factors it must

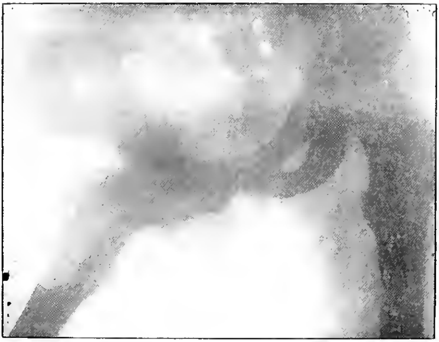


FIG. II.

and does exert an inward thrust upon the trochanter, crowding the femoral head into the socket. Dr. Allis reports that having had his fascia lata divided transversely on the outer side of his thigh, because of a deep abscess, he noted that the head of his femur "became partially dislocated with each step and returned with a decided jar and audible sound." He adds, "By degrees the tensor muscles shortened and re-established their former control; but the security has never fully returned."

In his Surgical Anatomy, p. 564, Deaver says, "Contraction of the fascia lata after hip-joint disease, paraplegia, infantile paralysis, etc., may call for division either of the fascia alone or together with the contracted tendons"—an observation which must repeatedly have been made by every member of this society. When we come to consider the mechanical changes present in an obturator dislocation, we shall note that more than any of the lesions just mentioned, they present conditions which, if perpetuated long enough, are ideal for bringing about a contracture of this fascia.

Of the fascia lata, Allis says "This structure is not concerned to any material degree in the subject of dislocations of the hip;" but Allis was speaking of fresh dislocations. I am unable to interpret the ease with which a reposition, presently to be reported, occurred after division of the fascia lata, except on the assumption that in ancient obturator luxations adaptative shrinkage of this structure constitutes *one* of the prin-

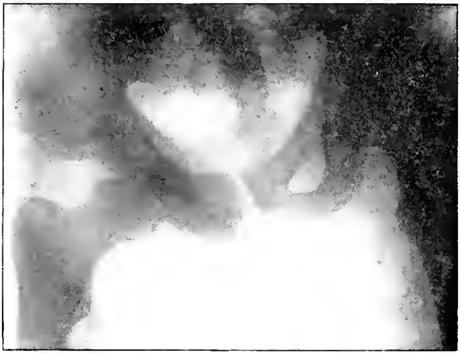


FIG. III.

cipal hindrances to reduction. The fact that several operators have accomplished repositions only after stripping the trochanter of its soft parts (*Skeletierung*) seems to me to be contributory evidence in support of this contention.

The Muscles.

With iliac dislocations there is always some damage of the pelvitrochanteric muscles. The quadratus femoris is always torn. (I have found a record of one case (Humphry) where it apparently escaped.) The femoral head is not a discriminating dissector, and depending upon the direction and protraction of the dislocating force, it plows its way backward and upward between or through the members of the group comprising, besides the quadratus, the gemelli, the obturator internus, and the pyriformus. (There is no agreement at all on this point among the authorities reviewed. Dollinger in 17 cases found only the quadratus injured.) There is also a marked relaxation with consequent adaptative shortening of the long axial muscles of the limb, a fact which would warrant the contention of Drehmann, Brünning and others, that in cases of this group efficient traction should precede open operation.

Obturator dislocations, on the other hand, are associated with a minimal amount of muscular disturbance. There may be some slight shortening of the external rotators, but repeated measurements have convinced me that it cannot be great.

On the other hand, Szenes, who in 1918 (two years later than myself)

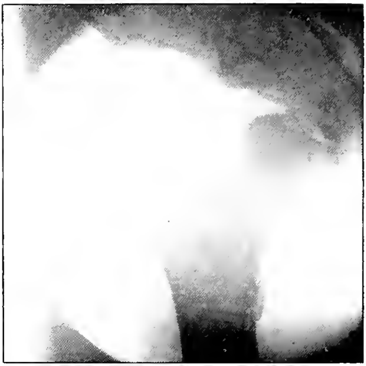


Fig. IV.

reduced an old obturator luxation by open operation after transforming it into an iliac dislocation, reports that he tore the shrunken quadratus and was compelled to cut the pyriformis. Incidentally his case, which was at first mobile, ultimately became ankylosed: this despite the fact that he found the socket empty and its cartilage intact, and in his after-treatment used approximately 23 pounds of skeletal traction. (Further evidence to support my contention that transformation of one luxation to another is a mistake.)

The Sciatic Nerve.

The sciatic nerve leaves the pelvis usually *below* the pyriformis, but sometimes through or above it, and passes from the sciatic notch across the internal obturator, the femoral neck, quadratus femoris and adductor magnus, to the popliteal space. The guide to it is the biceps which covers it, and with which it is loosely connected.

According to Allis, with the manipulative reduction by circumduction recommended by Bigelow, there is assurance of compressing the nerve between the femoral head and the pelvis, and danger of hooking it over the neck. Through this mischance the nerve has been pulled loose from its spinal attachment.

The Mechanism of Dislocations.

Since dislocations of the varieties under consideration regularly follow external violence, a glance at the skeleton will show that while the

Fig. V.

weight and the power are the same, a wholly different fulcrum must be used in producing the dislocations of the two fundamental varieties. Dislocations inward *must* occur in hyperabduction—the shaft representing the power arm, the inferior capsule the weight, and the trochanter or neck in contact with the upper rim of the socket, the fulcrum. Given these three factors, simple hyperabduction alone can burst the inferior aspect of the capsule, and cause the head to rise up out of the socket to be displaced downward and inward to rest in the thyroid fossa. On the other hand, in outward dislocations a bony fulcrum does not present itself. The power arm and the resistance are the same as before, but the fixed point or fulcrum across which they work has to be the ilio-femoral ligament, but it can become so only if it is wound up tightly on the femoral neck. In this type of dislocation we know the head leaves the socket after rupturing the posterior capsule, and this can occur only through inward rotation (which tightens the anterior capsule) and flexion and adduction, which directs the head against the weakest part of the capsule at a shallow part of the socket.

The difficulty encountered in reducing either variety of fresh dislocation must arise principally from a failure to recognize the several steps by which the dislocation has come about. Were such a series of steps recognized in their proper sequence, by reversing them, no great difficulty should be had in leading the head back into the socket. And

indeed such has been the fact in the few fresh cases which have come within my personal knowledge, though it is only fair to add that these were all, except two, experimental dislocations on the cadaver. When the doctor knew what to do, there was no great difficulty in doing it.

On the other hand, the problem of the ancient dislocation is a wholly different one, for here muscle shortening, cicatricial contractions, and inflammatory changes have so changed both the character and the relations of the tissues that a reversal of the steps of the dislocation may be, and usually is, no longer possible.

To the best of my belief, the case presently to be detailed represents the only instance in which an ancient anterior or internal dislocation was reduced without either transforming it first into the iliac or external type, or stripping the trochanter subperiosteally or cutting away bony obstacles to reduction in the shape of part of the pelvic wall.

The Case.

On May 2, 1916, D. S., a very powerfully built young Irishman of about 26 years, was brought to me from Tonopah, Nevada, with the history that on the fourth of the preceding March, while he was mucking in a mine, he had been injured by a cave-in, approximately two tons of rock having fallen on or about him. Examination at the emergency hospital showed scalp wounds, excoriations and contusions of right shoulder and buttock, and a lacerated wound of right knee, which had freely opened the joint cavity. It was noted that the right thigh was held in abduction, outward rotation, and moderate flexion, but the significance of this distortion was not recognized. Treatment for the recognized lesions was efficient, and by the time he reached me they were healed without resultant disability.

I had never seen an obturator dislocation, but the appearance of the man was so characteristic, with his right thigh abducted, flexed, and rotated out, with pelvis tilted toward the side of the lesion, and body weight thrown on opposite leg, that from inspection it was possible to make a diagnosis without removing his clothes. The diagnosis was sustained by the x-ray.

On the following day an anesthetic was administered, and the man's pelvis was fixed after the manner suggested by Dr. Allis, by means of a rope passing from screws set in the floor above the levels of the anterior iliac spines and between the thighs. Then while traction was made on the flexed and abducted thigh, a direct outward thrust was made in the groin by the stockinged foot of an assistant. The thrust was continued while the limb was carried into adduction. This maneuver was com-

bined with both outward and inward rotation. When the last named combined movement was carried out, the femoral head could be lifted out of the thyroid fossa and jumped up onto the anterior or rather antero-internal rim of the socket. This fact was verified by the x-ray, a reproduction of which I shall presently show you. It was not possible to replace the head in the socket, however, though these manipulations and modifications of them were persisted in for upwards of two hours. The man came out of the anesthetic without any feeling of soreness or external evidence of trauma—but the operator was exhausted.

During the following eight days the man's skin from lower ribs to toes was cleansed daily with gasoline and alcohol, and in the intervals wrapped in sterile gauze. At the same time, through the courtesy of Dr. Russell Ryan, I was enabled to get control of a cadaver and reproduce in it as nearly as possible the pathological and mechanical problem presented by my patient.

It seems not amiss to interpolate here that the rigidity of an embalmed cadaver, and the friability of its muscles render it only partially possible to reproduce even the anatomical and mechanical conditions present in a living body which has sustained a dislocation.

I found when I had created a dislocation downward in my cadaver that the rigid soft parts very largely refused to follow the bones in their changed relations. Anatomically, it was the same thing, but it didn't look like it.

My attempts at manipulative reduction had given me the impression that the head had been prevented from returning to the socket by an annular constriction about the neck, and from my reading I had learned to expect that the head would be inclosed in an adventitious capsule, and that the socket would be filled up with organized inflammatory tissue.

The cadaver presented at least the advantage that I could experimentally test the methods by which other operators had attempted to solve the problem which such a luxation presented.

Dollinger, with the largest personal statistics published, had come to employ a posterior incision extending from the base of the trochanter backward between the fibers of the great gluteus to the posterior inferior spine.

This ought to be an admirable approach for iliac dislocations where one would come down at once directly on the head and at the same time have an easy approach to the socket, but in the obturator type, with the trochanter overlying the lower part of the socket and the external rotators covering most of the rest of it, while the deeply placed head is still

more difficult of approach, this incision was found on the cadaver to be difficult and inconvenient. Out of five obturator luxations operated upon by this method, Dollinger obtained two actual repositions, both of which ultimately ankylosed. This is, however, the incision which, either alone or in connection with other incisions, is oftenest employed.

The posterior curved convex forward incision of Koeher was studied. Except that it can be made to divide the ilio-tibial band, it presents no advantage over the Langenbeck cut.

Ollier's transtrochanteric convex downward incision was attempted. This incision, with an insignificant modification, was that advocated afterward by Mikulicz, and later still by Murphy. It gave an excellent exposure of the socket, but still left the head difficult of approach. Also the long period of postoperative immobilization necessary for the re-attachment of the trochanter rendered this incision undesirable.

The Lorenz incision between tensor fascia and sartorius was excluded because in an obturator dislocation with the bone displaced inward it would come down on the trochanter where it lay against the socket.

The Larghi incision, employed with satisfaction at the Bergmann Clinic, skirts the iliac crests and permits the glutei to be reflected downward. It would appear to be very like the Sprengel and Smith-Petersen incisions and, like them, to give an excellent approach to the socket, but the head and the structures which hinder its return to the socket would still be at an inconvenient distance. Also postoperative immobilization might have to be undesirably prolonged.

The Hüter-Schede incision was unknown to me until I began to write this paper, when I found it recommended by Drehmann (*Deutsche Zeitschrift für klinische Chirurgie*, 1904). In his case, however, he was in the end compelled to combine it with the posterior incision of Langenbeck, and to do a complete muscular denudation of the trochanter before he could obtain a reposition. For the following description of this incision I am obliged to my friend, Dr. F. Fehleisen, discoverer of the erysipelas germ. "The longitudinal incision begins below and a finger's breadth within the anterior spine, passes straight down for ten to twelve centimeters; then the inner border of the sartorius and the rectus are uncovered and retracted outward. Now while the limb is flexed, abducted, and rotated outward, the joint capsule is widely opened and the femoral neck uncovered."

This was the first part of the incision I employed in reducing my dislocation. The second or transverse portion was suggested to me by Dr. Osgood for an arthroplasty of the hip which I subsequently presented before this society at our meeting in San Francisco in 1915.

Briefly, the detail of the operation was as follows: A five-inch longitudinal incision beginning just below and within the anterior superior iliac spine was met at its lower end by a transverse incision extending three or four inches outward. The sartorius was drawn outward with the rectus. The fascia lata was cut across. The capsule was opened transversely. This exposed the socket, which was found to be free of adventitious tissue. A blunt pointed hernia knife was now introduced and carried inward until it encountered the head. The constriction about the neck was opened freely, cutting downward and backward.

With the idea that the reduction might now be made with skeletal traction, the trochanter was uncovered by a longitudinal incision, grasped with the largest size Lane forceps and strongly pulled upon while the limb was distracted, abducted, and flexed, and then adducted with inward rotation.

This maneuver failed. The left forefinger was now introduced into the cut in the capsule and carried out toward the head. A tense band was encountered lying directly across the inner pole of the head. Pulsation was sought for but could not be felt; so the knife was introduced alongside of the finger and this band sawn through. It was exceedingly hard to cut. The Allis maneuver was again repeated, and the head at once entered the socket. It was now noted that the right-angled flap in our wound had become a sharp V.

Because of the extensive traumatization it was thought best to carry a gutta percha and gauze drain from the head out through the longitudinal cut over the trochanter. The capsule was not sutured, as the parts came together evenly. The external wound was sewn up tight and a double plaster of Paris spica applied.

The drain was removed in 40 hours and culture taken. It was found to be sterile. The lower portion of the V-shaped flap sloughed. A culture from it, taken as soon as the slough was discovered, was sterile. The site of the slough was eight weeks granulating. The white blood count rapidly fell to normal. The temperature never reached 100 degrees F.

The man was got up with a short spica and crutches by the end of the sixth week, and the spica removed two weeks later.

This patient was a State Compensation case, and not a very desirable citizen. When he learned that unusual interest attached to his case, he became difficult to handle. He could not be induced to flex his thigh beyond 30 degrees, though on November 8, six months after the operation, under anesthesia, I was able to flex it with no great effort to between 60 and 90 degrees. (When he waked up he had no notable discomfort.)

But I made the grave mistake of not immobilizing it in this position until the gain was permanent.

It is my judgment first that I should have immobilized his thigh in adduction and right-angled flexion, and second that I should not have held it in that position longer than two weeks, but should then have extended it to within a few degrees of a straight angle for a week, and then held it another week or two in flexion. I should then have got him up without apparatus and begun at once with my physiotherapy. Finally, when I got his thigh freely flexed on November 8, it was a grave oversight not to immobilize it in that position till the gain had become permanent. In that way I would have saved the man many months of partial disability, and my employers much disability compensation.

Not caring to trust my own judgment of my own work, I asked Dr. Sherman to examine him and give a prognosis of the ultimate outcome. His report follows:

"The Nevada Industrial Commission, Carson City, Nevada.

January 8, 1917.

Gentlemen:

I beg to submit herewith the report on my examination of D. S., whom I saw at the instance of Mr. J. J. Mullin and Dr. James T. Watkins:

This was a man upon whom Dr. Watkins had operated very successfully for obturator dislocation of the hip. He came for an estimate of his disability, present and prospective. At present the man can walk well; can sit down; can stoop about half; can squat about an eighth. He has about twenty degrees of flexion, fifteen degrees of abduction, a hundred and eighty degrees of extension, and fifteen to thirty degrees of rotation out and in. He is debarred from occupations requiring squatting, complete stooping or kneeling. He is competent only for occupations which permit of his standing or walking.

His general availability then for any possible occupation is about twenty-five per cent.; his disability seventy-five per cent.

Now, the range of motion in his hip can be increased almost to the full limit if the man will make the effort. Therefore, his prospective disability is very much less than his actual present disability, and should not be, I think, more than about fifteen or twenty percent. I am,

Very respectfully yours,

(Signed) Harry M. Sherman."

I am more glad than I can say—or you can know—to close this record of what would seem to have been an unusual case, with these words of commendation from a man long an ornament of this society, and at whose feet I sat with profit for twenty years.

DISCUSSION OF DR. WATKINS' PAPER.

Dr. Frederick Gaenslen, Milwaukee, Wis.: I wonder whether Dr. Watkins considered the incision of Ludloff, recommended for open operation on congenital dislocation of the hip, and also for arthrodesis of the hip. My experience is limited to one case in which I used this incision for an arthrodesis. I extended the incision downward with the leg in complete abduction and in rotation outward of 90°, and in that way I exposed the head in about the position I wanted it to correct the obturator dislocation. The approach is intramuscular, and no vessels of any size are encountered. After dislocating the head through the wound, towels can be clamped around the head, so that it sits upon the operating field as a billiard ball sits on the table, and you can readily denude the cartilage. The approach to the acetabulum is very good. I would like to ask Dr. Watkins if he considered that.

Dr. Fred Albee, New York City: I believe that Dr. Watkins very wisely devoted a large portion of his paper to the approach to the hip. I do not believe that in any part of surgery is the approach so important as in the surgery of the hip-joint. I had a few cases of dislocation and one of fracture-dislocation where not only was the hip dislocated in the position Dr. Watkins mentioned, but the head of the femur was broken off and lying beneath the gluteal muscles. In such cases I believe one should approach the hip-joint in the very best way he can, and then from that he can work to the dislocated head. Now the anterior incision Dr. Watkins mentioned will give a very good exposure of the parts in a thin subject, but in a very fat subject it gives a rather inadequate approach, and I believe if you extend that incision posteriorly similar to the Smith-Petersen approach, and to the Ambler operation, peeling off the muscles, you can increase your exposure as much as you like, and you will work easier and avoid traumatization by the practices of your assistants. I believe it will improve the approach. As far as the approach goes, in my own work I use two approaches, one an anterior approach for fractures of the neck of the femur, and the Smith-Petersen approach.

I congratulate Dr. Watkins very much upon the result. It is certainly a difficult surgical problem in a dislocation such as this of two or three or four months' duration.

Dr. James T. Watkins, San Francisco (closing the discussion): Endlich attempted the approach suggested by the Doctor without success. He ultimately reduced his dislocation through a posterior incision after he had chiselled off the inner aspect of the socket. Apparently he got a miserable immediate result, but noted that the man, who was a wood chopper, with a large family to take care of, ultimately walked with a pretty good leg. My impression is that Dollinger also tried that incision without result. I note what Dr. Albee says about fat patients. As you see by my pictures, my patient was fairly stout. I was compelled to do all of the deep work in this operation guided only by the sense of touch. One couldn't see anything. The

Germans have [illegible]
about the head of [illegible]
pieces of [illegible]
[illegible]
fill up with [illegible]
to it. In fact, if [illegible]
One hesitates to [illegible]
a single case [illegible]
that [illegible]
drainage to the [illegible]
in the [illegible]
fractures.

RETARDATION OF GROWTH FOLLOWING POLIOMYELITIS.

BY PHILIP W. NATHAN, M.D., NEW YORK, N. Y.

It is, of course, well known that growth is retarded after all forms of acute illness, particularly after infectious diseases. As a rule the retardation is not great and only temporary. But in some cases,—for instance, following typhoid,—the biological processes remain depressed for a long time and the growth of the individual is slow; the adult individual never reaches the full height. It goes without saying that in severe cases of poliomyelitis similar abnormal biological conditions and their sequelae prevail, so that it is to be expected that, for a time at least, children who have had a severe attack of this disease will, at least temporarily, remain behind their normal fellows in the rapidity of growth. This is most graphically demonstrated in twins of which only one of the children has been afflicted. In two examples that I have had under observation, the retardation of growth was considerable, although the affected child recovered without paralysis.

This general retardation of growth is not specifically mentioned by writers upon poliomyelitis, but I have no doubt it is well known to the majority of orthopaedic surgeons who see a great many cases of poliomyelitis, and I do not think it necessary, for the present at any rate, to demonstrate the actual conditions mathematically.

On the other hand, although retardation of growth in the paralyzed limb is always mentioned in the text books, the peculiarities of the condition and its actual relation to the paralysis and the trophic conditions are not, as far as I have been able to ascertain, fully discussed. In the course of examining many children with infantile paralysis, I have noticed that: (1) the shortening when present bears no direct relation to the number of muscles paralyzed. I have seen, for instance, many children with practically no voluntary power in the limb but without demonstrable shortening, though the condition had existed for a long time. On the other hand, there were others who had definite shortening who had lost very little power and that in only one or a few muscles. (2) The shortening bears no direct relation to the vaso-motor disturbance present. I have seen many children with mottled and cold extremities and recurrent ulceration in whom the affected limb was equal with its fellow.

However, although the retardation of growth bears no relation to the number of muscles paralyzed or the vaso-motor disturbance, it seemed to me there existed a fairly constant relation between the shortening and the paralysis of certain muscles. I found that in adults or older children, in whom the morbid conditions had existed for many years, a short leg always meant gastrocnemius, associated with or without tibialis posticus, palsy.

In these cases there was some atrophy of the limb and, in a very few, paralysis of other muscles, but the shortening so often accompanied gastrocnemius and tibialis posticus palsy without any other marked disturbance of voluntary muscle power, that it occurred to me there might be some causal relation between the two.

In order, if possible, to determine the actual correlation between the retardation of growth and the paralysis of the limb or other factors to be considered, I tabulated the cases from the 1916 epidemic in the poliomyelitis service of the Mount Sinai Hospital with this point in view. One hundred twenty cases from the 1916 epidemic originally attended this clinic. Forty cases no longer attend and 10 cases still attending who have practically no lost function need not be considered here. We have then, 70 cases with definite signs of paralysis, of which 15 have shortening of one inch or more within five years of the onset. These cases are tabulated below.

Name Number Age	First Shortening	Final Shortening	First Atrophy	Final Atrophy	Paralysis	Final Shortening Years	 Ins.
1 S. A.	1918 R. A. 16½ L. A. 17⅝	1921 R. A. 20½ L. A. 22½	1918 R. T. 10 L. T. 11½ R. C. 5½ L. C. 7½	1921 R. T. 9½ L. T. 12 R. C. 5½ L. C. 6½	Gastroc.— Tib. Post.— Calc. Valg.	5	2
2 17 mos.	1920 R. A. 20½ L. A. 19¾	1921 R. A. 21 L. A. 19¾	1920 R. T. 11 L. T. 8¼ R. C. 8½ L. C. 5½	1921 R. T. 11 L. T. 9 R. C. 8½ L. C. 5½	Gastroc.— Tib. Post. - Calc. Valg.	5	1¼
3 F. B. 4 years	1921 R. A. 19 L. A. 18	1922 R. A. 19⅞ L. A. 18⅞	1921 R. T. 10½ L. T. 9½ R. C. 7½ L. C. 6½	Not noted	Tib. Post.+— Gastroc.+—	6	1
4 F. C. 14 mos.	1918 R. A. 14½ L. A. 11½	1921 R. A. 20 L. A. 19¼	1918 R. T. 10½ L. T. 9⅛ R. C. 7¼ L. C. 6	1921 R. T. 12¼ L. T. 11 R. C. 8½ L. C. 7½	Tib. Post.—+ Gastroc.—+	5	¾

Name Number Age	First Shortening	Final Shortening	First Atrophy	Final Atrophy	Paralysis	Final Shortening Years	Ins.
5 E. M. 3 years	1920 R. A. 23¼ L. A. 23¼	1922 R. A. 25 L. A. 23¼	1920 R. T. 13¼ L. T. 10 R. C. 9 L. C. 7¼	1922 R. T. 13¾ L. T. 9¾ R. C. 9 L. C. 7½	Gastroc.—+ Tib. Post.—+	6	1¾
6 E. F. 3 years	Not noted	1921 R. A. 23 L. A. 24	Not noted	1921 R. T. 12¼ L. T. 11½ R. C. 8 L. C. 10¼	Gastroc.++ Tib. Post.—+	5	1
7 J. F. 4 years	1918 R. A. 20½ L. A. 20½	1922 R. A. 24 L. A. 24⅞	1918 R. T. 11 L. T. 9½ R. C. 7½ L. C. 6	1922 R. T. 12 L. T. 10½ R. C. 10 L. C. 6¾	Gastroc.—+ Tib. Post.—+ Peronei, sl.	6	⅞
8 E. F. 2½ yrs.	1919 R. A. 19 L. A. 19¾	1921 R. A. 20⅜ L. A. 21⅜	1919 R. T. 13 L. T. 13½ R. C. 8 L. C. 9	1921 R. T. 13 L. T. 14 R. C. 9 L. C. 10	Gastroc.—+ Tib. Post.—+ Ex. Dig., sl.	5	1
9 F. G. 3 years	1920 R. A. 23 L. A. 22½	1921 R. A. 25½ L. A. 23	1920 R. T. 13 L. T. 11½ R. C. 9 L. C. 7½	1921 R. T. 15 L. T. 13 R. C. 10 L. C. 7½	Gastroc.— . Tib. Post.— Calc. Valg.	5	1½
10 Y. H. 2 years	1918 R. A. 18¼ L. A. 17½	1921 R. A. 20¾ L. A. 19⅞	1918 R. T. 11¼ L. T. 10 R. C. 8 L. C. 6½	1921 R. T. 13 L. T. 11½ R. C. 9 L. C. 6¾	Gastroc.+— Tib. Post.—	5	⅞
11 J. J. 1 year	1918 R. A. 20½ L. A. 22	1921 R. A. 22½ L. A. 24	Not noted	1921 R. T. 9 L. T. 13 R. C. 6¼ L. C. 9¼	Flex. L. Hal.— Gastroc.— General weakness entire limb but performs functions	5	1½
12 J. L. 10 mos.	Not noted	1921 R. A. 19 L. A. 20	Not noted	1921 R. T. 9 L. T. 9¾ R. C. 6½ L. C. 8	Gastroc.—+	5	1

Name Number Age	First Shortening	Final Shortening	First Atrophy	Final Atrophy	Paralysis	Final Shortening Years	 Ins.
13 P. L. 3 years	1921 R. A. 19 L. A. 18	1922 R. A. 20⅜ L. A. 19¼	1921 R. T. 13 L. T. 10 R. C. 8½ L. C. 6½	1922 R. T. 12½ L. T. 9½ R. C. 9 L. C. 7¼	Gastroc.—+ Tib. Post.—	6	1¼
14 F. L. 8 mos.	1920 R. A. 21¼ L. A. 20¼	1922 R. A. 23 L. A. 21¾	1920 R. T. 13¾ L. T. 11½ R. C. 9 L. C. 7¼	1922 R. T. 13¾ L. T. 12½ R. C. 9 L. C. 7½	Gastroc.— Tib. Post.—	6	1¼
15 A. M. 3½ yrs.	1919 R. A. 19½ L. A. 19⅞	1921 R. A. 23 L. A. 23½	1919 R. T. 11½ L. T. 11¼ R. C. 6 L. C. 7⅝	1921 R. T. 13½ L. T. 13½ R. C. 6½ L. C. 9	Gastroc.+– Quad.+—	5	½

A glance at this table establishes the fact that all the children with short legs have the gastrocnemius involved. In one case the paralysis involves the gastrocnemius alone; in 10 the gastrocnemius and the tibialis posticus were the only paralyzed muscles; in one the gastrocnemius and the peroneii; in one the gastrocnemius and the extensor longus digitorum slightly; in one the gastrocnemius and the quadriceps partially, and in one the gastrocnemius was associated with paralysis of the flexor longus hallucis and general weakness of the limb.

Of the remaining cases, 10 had paralysis of both legs, and of these, two, with more or less general paralysis, had shortening of one-half inch five years after the onset. In none of the 54 unilateral cases without shortening was the gastrocnemius definitely involved, and in only two was the tibialis posticus associated with the other muscles paralyzed. I think the findings in these cases confirm my impression that there is a more or less definite relationship between gastrocnemius or gastrocnemius and tibialis posticus palsy and retardation of growth in the affected limb in poliomyeltis. Theoretically it would seem that the origin of the gastrocnemius near the lower femoral epiphysis and the loss of stimulation due to its absence would explain the connection. But the actual measurements show that the retardation of growth is not in the femur at all but in the leg, so that this factor must be eliminated. Nor can the loss of function in the gastrocnemius be the only deciding factor in the retardation of growth of the lower epiphysis of the tibia and fibula.

The os calcis, it is true, no longer rotates on the articular surface of

the tibia, but the individual still walks on the heel, and the stimulating influence of stress in this region persists, though the gastrocnemius is relaxed.

Thus the cases in this series definitely show that gastrocnemius and tibialis posticus palsy almost invariably lead to retardation of growth in the epiphysis (probably the lower) of the leg, while the growth in the other epiphyses remains unaffected. Though the causal relation between the paralysis and the retardation of growth is not elucidated, it is certain that it is not due to vaso-motor disturbance nor can it be due entirely to abnormal mechanical conditions.

In contrast to the constant retardation of growth when the above-mentioned muscles are paralyzed is the fact that there is practically no retardation of growth when the limb as a whole, with the exception of these muscles, is paralyzed or when there is marked paralysis of the muscles of the thigh or the muscles of the fore part of the foot. The careful measurements taken in this group of cases bear out the impression of years of experience with poliomyelitis; for although I have in my records cases in which there was lengthening, I can find only a single case of general paralysis of the whole leg in which there was shortening, and in this the gastrocnemius and the tibialis posticus were completely paralyzed with the other muscles.

The cause for this peculiarity I hope to show in a future communication.

ON COXA PLANA AND ITS CAUSATION.

A Theory Presented to the American Orthopedic Association in Washington, D. C., on the 2nd of May, 1922.

BY DR. MURK JANSEN OF LEIDEN, NETHERLANDS.

The femoral head and neck, when being deformed to the condition which was first described by Dr. Legg, pass through the following phases:

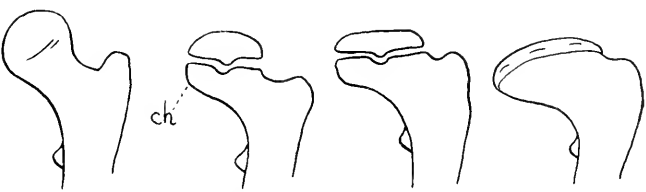


Fig. I. Fig. II. Fig. III. Fig. IV.

Starting from the normal condition, represented by Fig. I, the growth disc is seen to approach the horizontal position (Fig. II) and the femoral neck at the same time tends to develop a "chin"-shaped protrusion (*ch* Fig. II). Moreover, the head often shows a lateral displacement, its lateral edge projecting beyond the lateral border of the neck ("*head-in-neck*" position), and slight irregularities in the plane of the growth-disc may present themselves. Next a widening out of the neck and a flattening of the head become noticeable (Fig. III), until after some trauma or an intercurrent disease, or also without any traceable reason, the femoral head shows excessive flattening with fragmentation of its bone centre (Fig. IV), when *coxa plana fragmentata* is developed.

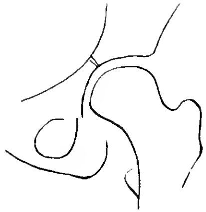


FIG. V. Normal Socket.

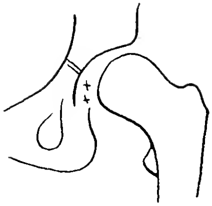


FIG. VI. Shallow Socket (through thick socket floor).

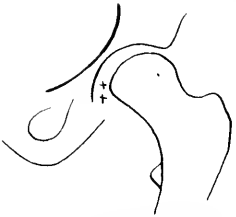


FIG. VII. Wide Socket (through ischium varum).

On further growth these fragments reunite and form a wide femoral head in the adult.

It has hitherto escaped the attention of investigators that besides these phenomena in the femoral head and neck the *socket* regularly shows characteristic changes. In all our cases, and in many cases represented in literature, we have found either the floor of the socket too thick, *i.e.*, we found a socket which is too *shallow*, or a socket which is too *wide*, due to the fact that the ischium is swung medially over a few degrees so that the ischial part of the acetabulum is displaced medially—a condition we term *ischium varum*. Though in the case of a too thick socket-floor the socket is primarily too shallow, and in ischium varum the socket is primarily too wide, in both cases the socket is part of a sphere too wide for the head. In both cases the socket is too shallow, and might be shortly spoken of as *flattened socket*. These changes in the acetabulum alter the mechanical conditions in the femoral head and neck, and of these mechanical changes the development of the symptoms of coxa plana will seem to be the natural result.

In the erect posture the wide and shallow socket is in contact only with

the upper portion of the femoral head, a gap being left between the medial part of the head and the socket. (It is understood that the upper portion of the socket is normal, running practically in a horizontal direction.) The functional stresses which are normally transmitted from the whole of the socket surface to the whole of the femoral head, and reversely, are thus concentrated over a small area of head and socket.

The resultant of these stresses normally coincides with the axis of the femoral neck, as may be gathered from the internal structure of the femoral head and neck. This resultant may be separated into a vertical component, *v* (Fig. VIII) and a transverse component, *t* (Fig. VIII), each of which seems to be responsible for the development of a certain group of symptoms in coxa plana:

The *vertical stresses* thronging into the femoral head through the small area of its surface that is in contact with the socket are transmitted through the femoral neck largely by the bone-elements, *a* (Fig. IX) passing through the lateral part of the growth-disc. These are, therefore, made to bear undue pressure, the effect of which is to be expected both in the growth-disc—*i.e.*, in the way new bone is to be formed—and in the bone substance that has been formed previously. The medial part of the growth-disc, normally transmitting stresses through the bone-elements *b* (Fig. IX) is relieved of such stresses. Hence there is an increase of pressure on the lateral part of the growth-disc and a decrease of pressure on the medial part during the eret postur in subjects with a flattened acetabulum. It is well known that increase of pressure may lead to decrease of growth and decrease of pressure to increase of growth, and we have brought forward grounds for the assumption that this is

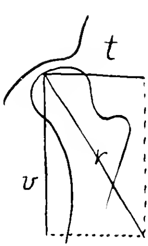


Fig. VIII.

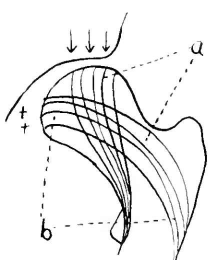


Fig. IX.

especially apt to occur in subjects whose power of growth has been enfeebled by some injurious agent that has befallen them either before or after their birth.[1] The development of knock-knee is a classical illustration of this. The undue pressure through the lateral portion of the growth-disc of the femoral head and the diminution of pressure in the medial portion may, therefore, contribute to displacing the growth-disc into the horizontal position and even to the formation of the "chin" (*ch* Fig. II) on the inner border of the neck. In a study "On Bone Formation"[2] we have brought forward arguments favoring the assumption that apart from growth changes, bone (that has been previously formed), when submitted to undue weightbearing, may absorb lime salts and become plastic. The concentration of the vertical stresses through the lessened area of femoral head and neck, *i.e.*, through the bone-elements *a* (Fig. IX), means undue weight bearing to them. Thus the shortening and thickening of the femoral neck and the flattening of the head may be the result of this excessive pressure. And as this pressure makes itself felt in the lateral portion of the neck, it may also have a share in the horizontal position of the growth-disc through compression apart from growth. The manifestation of this share may be found in the fact that the *growth-disc* is distinctly *curved* in many of the completely developed cases of coxa plana, its lateral portion being displaced more downward than the medial portion.

The forces of the *transverse component t* (Fig. VIII) originate on or near the trochanters and push the femoral head medially along the upper surface of the socket. They evoke shearing stresses between head and neck in the growth-disc, and these may account for the lateral displacement of the head as well as for the irregularities in the growth-disc.

As the femoral neck is getting wider and thicker, the growth-disc is spread out over an ever-enlarging area. It, therefore, seems plausible that rents should develop in it, and the same holds good for the bony part of the femoral head.

Thus shallowness of the acetabulum may be made responsible for all the characteristic symptoms of coxa plana, if it is assumed that bone in its growth and in its formation responds to enhanced mechanical stresses following certain rules which we have tried to lay down in the studies quoted in the above. Or shortly: *flattened head* seems to be *due to flattened socket.*

With the widening out and flattening of the head its form draws nearer and nearer that of the socket. This means a diminution of the

incongruence of head and socket, an enlargement of the area of contact, *i.e.*, of the area available for the transmission of stresses. The whole of the development of coxa plana, therefore, appears to us as a manifestation of the power of mutual co-aptation of the articular ends, a power which must be admitted to exist in all joints, and which shows itself to excess only in the congenital incongruence of the normally relatively heavily burdened femoral head and neck, as has been described in the above. This view is corroborated by the fact that the roof of the socket often shows changes which are equally characteristic of such an attempt at co-aptation.

The co-aptation, however, often remains incomplete in many cases of flattened socket and head. This is shown by the fact that adults relatively often present themselves with all the symptoms of flattened socket and head in which, nevertheless, the characteristic phenomena of joint-wear have developed. In them the fragments of the head have reunited and the growth-disc has naturally disappeared, but the joint line is too narrow in the upper part, indicative of the fact that the joint cartilage is worn off in that region, the outcome of local wear due to the insufficiency of co-aptation. This and the lipping which may be present in the borders of socket and head mark the condition as one of "joint-wear," —officially, though not appropriately, called "osteo-arthritis."

It is well known that coxa plana is a satellite of congenital dislocation of the hip, and reversely. It will occur with congenital dislocation of the hip in the same individual or in the same family,—for instance, coxa plana on one side and congenital dislocation of the hip on the other side of the same individual, or congenital dislocation of the hip in the mother and coxa plana in the daughter. With relatively high frequency also coxa plana will develop after reduction of congenital hip-dislocation. This co-relation may be easily understood, if for the thick socket-floor and for ischium varum the same cause is assumed that Le Damany has pointed out for congenital dislocation of the hip:—the amniotic sac, which remains too small and flexes the hip to excess, levers the femoral head out of the socket, the pelvic border acting as a fulcrum, and causes congenital dislocation of the hip (Le Damany). If there is less pressure from the amniotic sac, there may be just enough to lessen the normal pressure of the head against the socket-floor and to prevent the normal deepening of the socket, thus leaving too thick a socket-floor. And in other cases, too small an amniotic sac may be drawn too tightly over the sitting bones, and bend both of them inward, if the pelvis is lying symmetrically, or bend only one of the sitting bones inward if the pelvis is

not lying symmetrically, but lower on that side. Thus flattened socket, either through too thick a floor or through ischium varum, may be classed among the congenital malformations brought about by too small an amniotic sac.

It need hardly be mentioned that too thick a socket-floor, which is constantly present in the reduced congenitally dislocated hip, will favor the development of coxa plana. It also stands to reason that too thick a socket-floor is sometimes found to be combined with ischium varum on the same side, and means enhanced chance for the development of coxa plana.

Some investigators have tried to make microbes responsible for the development of coxa plana, and while some have sought in vain for bacteria by open operation, in a small number of cases bacteria have been cultured from coxa plana. This is not in contradiction to the mechanical nature of the condition. In every tissue, indeed, that is broken or torn mechanically, the chance is enhanced for bacteria, circulating in the body, to settle down and develop at the site of damage. However, a number of facts are opposed to the assumption that bacterial inflammation should be an essential factor in the development of coxa plana, because:

1. Patients with coxa plana are regularly distinguished from those with bacterial inflammations by their healthy appearance, the small amount of pain, the absence of fever, and mostly also by the absence of reflex stiffness and restriction of movement throughout life, except that which is brought about mechanically by the thickening of head and neck;

2. Bacteria cannot explain the thickness of the socket-floor or the ischium varum, the "head-in-neck" position, the horizontal position of

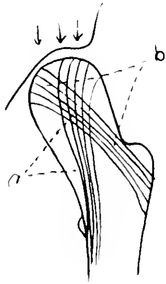


Fig. X.

the growth-disc, and the co-relation with congenital dislocation of the hip.

It should be noted that the flattening of the head does not in all cases pass through the four stages represented in Figs. II-IV. Cases of incomplete flattening in adults with flattened socket are not rare. The reasons may be different. The stronger the individual, *i.e.*, the less his power of growth is enfeebled, the better will head, growth-disc, and neck be able to resist the unusual stresses. Moreover, periods of rest may have been a factor in the arrest of the deforming process. Furthermore, congenital coxa valga, a frequent associate of flattened socket and of congenital dislocation of the hip, shows a tendency to preserve the normal shape of the head and neck in cases of flattened socket. This may be understood if it be borne in mind that, in proportion as the femoral neck draws nearer the vertical position, more of the convex-sided bone-elements *b* (Fig. X) are made to transmit pressure both to the medial and the lateral side of the neck, thus relieving the concave-sided elements *a* (Fig. X) of their excessive weightbearing. Reversely, as the femoral neck departs from the valgus position, its convex-sided bone-elements are more relieved from weightbearing, which to them means atrophy and to head and neck increased tendency to develop coxa plana.

As the femoral neck approaches the varus position in cases of flattened socket, it tends to an increase of the varus position or even to a fracture of the neck. We have repeatedly observed coxa vara or fracture of the neck on one side of a boy or girl with flattened socket on that side and a normal hip on the other side. This may be due partly to the above atrophy of the convex-sided bone-elements, partly also to the fact that in coxa vara the direction of the concave-sided elements *a* (Fig. XI) does not—as it practically does in coxa valga—coincide with that of the

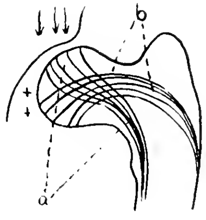


FIG. XI.

vertical stresses, and lastly also because the moment of the vertical pressure on the head becomes greater as the neck approaches the horizontal position. Thus monolateral coxa vara, which has been hitherto unexplained, may be understood, when it is attended by a flattened socket which, for that reason, bears weight only on the upper portion of the femoral head. It is needless to say that here again enfeeblement of the power of growth favors the development of either varus-position or fracture.

All in all, flattened socket (either due to ischium varum or to thick socket-floor) may be made responsible for a large number of changes in the femoral head and neck by the application of rules we have tried to establish for the formation and growth of bone, and the primary cause may be identified with that of congenital hip-dislocation, with which these changes appear to be co-related.

As for the treatment, it should be borne in mind that the process met with in coxa plana is an attempt at self-help of nature to do away with an incongruence of head and socket. Undesired plasticity of head, neck, and socket should be forestalled or checked by rest, eventually combined with traction. It may be assumed that bone which has become plastic through undue weightbearing will deposit new lime-salts and become firm again when it is relieved of weightbearing for a number of months, after which gradually increasing weightbearing may be allowed. In most cases the relief of weightbearing may be combined with free movement of the hip either in recumbency or in walking with crutches with a mitten under the well foot. Coxa vara, as well as fracture of the neck, requires special measures.

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DISCUSSION ON PAPER OF DR. JANSEN.

Dr. D. B. Phemister, Chicago: I shall limit myself in the discussion of this interesting paper to the presentation of two cases which show the possible relationship between infection and the development of the changes in coxa plana. They support the contention that the primary lesion may be an epiphysitis of the head of the femur and that the subsequent changes are secondary to a breaking down of the bony center and collapse of the cartilaginous head.

The first case, previously reported (Operation for Epiphysitis of the Head of the Femur (Perthes' Disease), Findings and Result, *Archives of Surgery,* 1921, Vol. ii, p. 221), is that of a boy 10 years of age who entered the Presbyterian Hospital of Chicago with a typical history and physical findings of

coxa plana of the right hip of five months' standing. An x-ray picture showed flattening of the head with an area of reduced density in its central portion. He left the hospital without treatment and returned four months later, when a second x-ray picture showed more marked collapse of the head and extensive destruction of its center of ossification with two irregular dense shadows suggesting the presence of sequestra. An operation was performed in order to determine the nature of the changes and the effect of cleaning out the broken-down center of ossification. The joint was exposed anteriorly, several c.c. of a straw-colored fluid were aspirated and the synovial lining was opened. A mild synovitis was found with several synovial tags. The articular cartilage of the head was smooth and shiny, but bulged markedly in its lateral portion. A window was excised from the anterior portion, which exposed a broken-down center of ossification filled with necrotic débris and containing numerous sand-like particles of necrotic bone as well as two definite sequestra about the size of peas. After curettage of the epiphyseal head, the hip-joint was closed and a plaster-of-paris cast applied for two months. Aerobic cultures made of the synovial fluid and of the tissues removed from the head were negative. No anaerobic cultures were made. Histologic examination of the synovial lining showed a chronic synovitis with areas of round-cell infiltration. Sections of the material removed from the head showed a mixture of granulation tissue in various stages of organization and necrotic débris containing numerous small sequestra. Microscopic examination of the pea-sized masses of bone showed them to be made up entirely of dead bone. There was absence of tubercle bacilli in sections stained for them. My interpretation is that the process was a quiescent inflammatory one.

X-ray pictures made two and five months after the operation showed a rapid re-formation of the bony center with the cartilage in the same position of collapse as at the time of operation. Other pictures taken in the course of the two years following showed a complete disappearance of the active signs of disease and there is a fair range of motion in the joint. The rapid reorganization and ossification without further flattening, which followed operation, suggest the advisability of operation in cases that are seen comparatively early and show marked evidences of destruction with sequestration.

The second was a case of Dr. G. L. McWhorter's, a boy 10 years of age, with chronic nasal infection, who was admitted to the Hospital thirty-six hours after the onset of symptoms. He had pain and rigidity in the right hip, a temperature of 100.6 degrees and a leucocytosis of 19,000. Osteomyelitis of the upper end of the femur was diagnosed and the base of the neck and the shaft of the femur three inches below the trochanter were exposed and cut into with negative findings. Cultures of tissues removed from the neck yielded one colony of staphylococci, which was in all probability the result of contamination. The disease ran a mild febrile course for 10 days and the wound healed in three weeks with little evidence of infection. X-ray pictures taken two weeks after the onset showed slight flattening of the femoral head wih irregular margins and increased density of the convex portion of the center of ossification in the epiphysis. Eight months later a second x-ray picture showed typical findings of coxa plana.

The histologic findings in the first case and the clinical picture at the onset of the second case suggest that in both of these instances the disease was inflammatory in nature.

Dr. A. H. Freiberg, Cincinnati: For me to speak at any length on this subject would be, I think, a great injustice to the rest of the program for the day.

I cannot refrain from expressing my very great gratification and pleasure at hearing the paper of our esteemed visitor and colleague, Dr. Jansen. It would not be becoming in me to say anything very critical of what has been presented to us this morning in so very interesting a way, because I have not had the opportunity of thinking about it carefully in the degree which it merits. The thing that must strike every one who examines a number of such pelves and hips as the orthopaedic surgeon is doing is that it is incumbent upon us to distinguish between cause and effect. A considerable number of observers have studied this subject. Some years ago I myself cast upon an unsuspecting medical world a paper on the theory of this disease. This condition is looked at from different points of view. We have several men who look at this condition as preëminently of traumatic origin. This was the view our distinguished colleague, Dr. Legg, had when he gave us the first description to be found in the literature, or at least as early as any to be found in the literature. The condition found in congenital hips which had been subjected to considerable trauma I shall not discuss at this time. You will see from the slides that there is very much to recommend Legg's views. We have the infectious view which Dr. Kidner advocates and with which I agree. The condition which we have been calling osteoarthritis deformans juvenilis is the terminal phase of this disease. I have a number of such cases that I have been able to trace.

Then we have the purely mechanical cases, which some of our French colleagues would have us believe were congenital subluxations of the hip. That, to their mind, is the explanation of all. To me, aside from the fact that the infectious theory has some exceptional aspects, such as Dr. Phemister has shown, or such as are to be found in Dr. Kidner's cases, very few cases must furnish the occasion for opening the joint. I believe we may learn or should try to explain this condition, interesting as it is, by an ever so careful study of ever so many x-ray plates. We should study the sections if we are able to get them. I think we should endeavor to get more information on our cases. This is a peculiar condition which has a certain similitude to other obscure conditions. It is similar to Koehler's disease of the scaphoid. It has a certain similarity to what I have described under the title of infraction of the second metatarsal bone, which has now been described by others. It is a peculiar condition, which begins at a certain time, goes through a certain evolution and then stops. We may search in vain for certain anomalies of structure to explain this condition. The factors producing the condition may be trauma in one case and infection in another. It may be that neither of these is required, but simply an abnormal state of local mechanics, such as our honored guest has shown us this morning. Nevertheless, it is a most seductive subject for study and one in which we are going to learn more as the years go by. I think we will learn more if we study it from a broad point of view and not from a narrow standpoint.

Dr. F. R. Ober, Boston: Dr. Legg asked me to show a few of his slides of flat heads, and the first one is the end-result in a case which he saw in 1910. (Slides.)

Dr. Legg still believes in the traumatic theory and sees no adequate reason for changing his views. In no case has there been a white blood count of over 12,000, and in 30 examinations we have had negative Wassermanns. On physical examination we have never seen the symptoms one would expect in

acute infection. There is very little pain in proportion to the amount of disability on passive motion. Abduction is markedly limited. Sometimes internal rotation at a right angle cannot be obtained. We have never seen in any of these cases any marked lighting up of symptoms or any stormy symptoms during the whole period of the disease.

I would like to ask Dr. Jansen first, if the condition be due to an ischium varum of congenital origin, why does not the flattening occur early instead of at varying ages?

Second, has Dr. Jansen any explanation to offer concerning cystic formation, occurring in these heads after the flattening has become well established?

Third, why does the lower portion of the head, where weightbearing is at a minimum, flatten as much as the upper portion, where weightbearing is at a maximum?

Fourth, if ischium varum is to be used as a working hypothesis, should we not find out how often it occurs in normal individuals?

We have all seen x-rays of tuberculous hips which show ischium varum, and it is my belief that it is due to a tilting of the pelvis on the plate brought about by atrophy of the gluteal muscles, present in chronic hip conditions.

Dr. F. C. Kidner, Detroit, Michigan: It seems to me that this condition, as Dr. Freiberg has stated, must be looked upon much more broadly than we have been doing in the past. I do not believe that the set of symptoms which we have learned to know as Legg's disease or Perthes' disease is due to any single causative factor. Dr. Jansen has just given us a new cause which may produce the same anatomical changes as occur in Legg's disease. I still believe with Dr. Phemister that most of the cases are infectious. Some are in the epiphysis and some outside the epiphysis. I have recently had occasion to operate on three such cases, not to find out what was inside, but because the patients had acute symptoms for a period longer than usual, and I did not feel justified in letting them alone. One of them had the typical vacuoles just outside the line of growth between the epiphysis and the neck. One had what I thought to be an acute osteomyelitic cavity of the Brodie type farther out in the neck. He also had a true fragmentation of the epiphysis. All three were negative on culture, and all three provided granular masses of bone which on microscopic examination were said by the pathologists to be infectious in origin, though they were not willing to give any idea of the origin of the infection. I have not the material of these three cases with me because they are still under observation. All three are now being treated by fixation. Coxa plana or Legg's disease is, then, a process which leads to softening and flattening of the femoral head and neck in children. The cause of this process may be any one of many things, such as trauma, infection, or nutritional disturbance.

Dr. R. B. Osgood, Boston: Just to add to the interest of the subject, I wish to report a recent case from the Massachusetts General Clinic, a boy of 16 years, with the typical appearance of this symptom-complex, a little older than usual, and with the symptoms of comparatively short duration. Because of the infectious theory of Dr. Phemister and Dr. Kidner, and the probability that it existed here, Dr. Smith-Petersen investigated. We were unable positively to rule it out, but there were no signs of infection present. Because of the possibility of arthritis deformans or hypertrophic arthritis, as an end-result of all these cases, as Dr. Freiberg has pointed out, and as has been suggested by Dr. Ober's slides, we considered it advisable to explore the hip. Although the x-ray showed the typical picture of Legg's disease, when Dr. Smith-Petersen explored the hip-joint with as good an exposure as his incision gives, it was impossible to say there was a single abnormality of appearance. There was a good round head without flattening. A small section was taken out from the epiphyseal line, and that fragment has been examined very carefully by Dr. James Homer Wright. The cultures were negative. All we can get Dr. Wright to say is that it shows no signs of chronic inflammation and no signs of tuberculosis. There is a very definite change of nutrition. There is a nutritional change in the section of bone taken out. I think the position taken by Drs. Freiberg and Kidner is one we should all take, that there may be multiple causes of this symptom-complex.

Dr. B. H. Whitbeck, New York City: Just one question. In the discussion of Dr. Dennucé's method of reduction of congenital dislocation it was brought out that in the Lorenz method a number of cases had developed the condition of coxa plana. It was thought that this was due to the violent manipulations of the surgeon. I would like to ask Dr. Jansen what is his opinion as to the cause of this coxa plana following reduction, whether it is due to reduction or to abnormal anatomic conditions under which the child had to walk.

Dr. Jansen (closing the discussion): It is not difficult in medicine to mix up various conditions. It is more difficult to segregate them and trace the processes separately. You have seen on the slides that flattened socket is present in all my cases of coxa plana. So there is a mechanical factor in the production of the condition. Suppose there is as well a bacterial factor. Even then the accurate study of the mechanical factor would be essential in order to determine for what part the microbes come in. Without such discrimination the solution of the problem seems much more difficult, if not impossible.

It has been asked: "Why does not the flattening of the head occur earlier in life?" The flattening of the head proceeds as the widening of the head develops, and fragmentation occurs only after the widening of the neck has come about. It takes some time for the neck to widen out. Therefore we need not be surprised that the flattening does not occur earlier. At all events the fact that the development of coxa plana is so intimately connected with the second five years of life seems to plead against the bacterial hypothesis, since bacteria are less bound to age.

On the occurrence of cysts in the long bones, we had a very interesting paper yesterday, and the suggestion was made that traumata might sometimes be made responsible for them. The translucent area which is often seen below the growth-disc in coxa plana may be of the same nature as the translucent spots which the socket-roof often reveals. They may indicate the spots

where excess of weight-bearing has led to the most obvious absorption of lime-salts. However, since their traumatic origin is not excluded, they do not plead against the mechanical theory of coxa plana.

Why flattening of the lower portion of the head occurs as well as in the upper part? It must be assumed that the upper portion of the socket, together with the limbus cartilaginus, bears weight on the head. I have always found socket and head to run practically parallel in their upper portion. So this, as all I know of coxa plana, confirms my view that *flattened head is caused by flattened socket.*

RESULTS OF TENDON TRANSPLANTATION FOR INTRINSIC HAND PARALYSIS. (NEY'S OPERATION.)*

BY J. G. JOHNSTONE, LONDON.

In my short experience of peripheral nerve injuries, particularly of the median and ulnar, I have been very much impressed by the poor functional result after suture where there has been a combined lesion. This is entirely due to the want of return of voluntary power in the hand intrinsics, especially the thumb intrinsics. The percentage of recovery of the intrinsics is about 7 per cent. to 9 per cent. Time and experience have shown that the most that one can hope for after a median and ulnar suture in a combined lesion is a very fair return of useful sensation in the areas supplied by these nerves plus the return of voluntary power in most of the extrinsic muscles of the limb. This leaves the patient with a very crippling disability,—*viz.*, the failure of being able to appose the thumb to the other fingers, especially to the index finger. The average result of a median and ulnar lesion twelve to eighteen months after suture is the typical simian hand,—the fingers extended at the metacarpo-phalangeal joints, the thumb extended at the metacarpo-phalangeal joint and lying in the same plane as the palm of the hand. Where only one of these nerves is injured the picture is somewhat different and the resultant disability is not so great.

There are several causes operating against the recovery of voluntary power in the hand intrinsics, namely:

1. The location of these muscles.

2. The time taken for the regenerating motor neuraxones to reach the motor end plates in these muscles.

3. The small caliber of these muscles, which readily waste and fibrose so that when the young neuraxones arrive there is very little muscle fiber left to function.

4. The difficulty of posturizing these muscles; namely, the lumbricales relaxed by right angle flexion at the metacarpo-phalangeal joints and the thumb apposed into the palm of the hand.

5. The dangers of producing joint stiffness in the fingers by the necessary prolonged immobilization.

*Read before the British Orthopaedic Association, October 20, 1922.

How can these difficulties be overcome and combated by the means at our disposal? To take them *seriatim:*

1. The location of these muscles obviously cannot be altered.

2. The regeneration time, twelve to eighteen months after suture, depending on the site of the lesion, cannot be reduced by the present recognized methods of treatment.

3. There are no methods known by which one can prevent these intrinsics wasting and becoming mere fibrous cords.

4. The retention of these muscles in a state of relaxation favorable to the return of voluntary power is a very real difficulty. A satisfactory splint is very difficult to make, and irksome both to apply and wear, as it requires careful daily fitting. A plaster of Paris splint, to be made comfortable for the patient and at the same time to act efficiently, requires accurate fitting and constant renewal. Indeed, I think that the time and money spent by both surgeon and patient on these articles will be poorly rewarded. The posturization of the hand intrinsics has proved of doubtful value in assisting their recovery.

5. The risk of production of joint stiffness. No amount of daily massage and mobilization of the several joints of the fingers and hand is going to prevent the occurrence of joint changes during the course of twelve to eighteen months waiting for voluntary power to return. If one decides to adopt splintage in these cases I believe it is a wise precaution in cases of median and ulnar paralysis to keep the hand periodically free of all splints except in those where flexor contracture is tending to, or has already, developed.

Consequently, although one has seen very extensive muscle recovery in these cases of median and ulnar paralysis, the functional result is not good, because the apposing action of the thumb has not returned. One is therefore driven to seek other methods than the above to improve the patient's condition. In my search for this I came across an article by Winfield Ney,* New York, in which he advocates the transplantation of the extensor brevis pollicis into the flexor carpi radialis or the palmaris longus. Ney advises this procedure not only as a permanent tendon transplantation but also as a method of posturization of the opponens, in the hope that this muscle will in due course return to voluntary power after a period of relaxation. This latter method I have not adopted because the cases I have seen have been so long after the date of the original injury that the hope of recovery in the opponens was remote.

*Surg., Gyn. and Obstet., October, 1921.

I have had an opportunity of doing only two such operations myself. In both these cases I have used the tendon of the flexor carpi radialis in preference to the palmaris longus, which latter muscle Ney prefers, presumably because thereby he does not diminish the patient's power of wrist flexion. I have used the flexor carpi radialis because the palmaris longus was such a deficient muscle in both cases. Also I have not followed Ney's recommendation to anchor the tendon of the extensor brevis pollicis to the uncut flexor carpi radialis tendon, because I could not see that the resulting simultaneous action of flexion of the wrist and apposition of the thumb was going to be easy to perform or useful to the man. Even in the normal hand these two actions attempted simultaneously are difficult. To appose the thumb one can do it most easily with the wrist held in extension or in the mid-position between flexion and extension. I cut the tendon of the flexor carpi radialis from its insertion so that its ultimate action would be that of apposition of the thumb.

The technic and delicacy of handling the tendons are those which are common to all tendon transplantation operations, so that I need not spend time in dealing with these.

Operation.—I. An incision is made along the line of the tendon of the extensor brevis pollicis about three inches long. The tendon is demonstrated lying on the dorsal side of the extensor ossis metacarpi pollicis and in close relation to it. The tendon is cut at its proximal end and carefully dissected distally after opening its sheath as far as within two cms. of the metacarpo-phalangeal joint of the thumb. At this stage of the operation it is well gently to grasp the proximal end of the cut tendon to test its action, as occasionally this tendon at the site of the metacarpo-phalangeal joint is adherent to the tendon of the extensor longus pollicis and aids in extension of the terminal phalanx. If this is found to be the case then one must free these two tendons to prevent this action taking place after transplantation. The tendon to be transplanted must act only on the metacarpo-phalangeal joint of the thumb. The tendon is now wrapped in gauze dipped in saline, and laid aside.

II. An incision is now made three inches long over the tendon of the flexor carpi radialis at the wrist joint, half of the incision running into the palm and half up the arm, the tendon of the flexor carpi radialis is found and freed until it runs under the annular ligament, which is incised for half its breadth. The tendon is cut from its insertion. A tendon transplanting forceps is now run from the distal end of the palmar incision under the annular ligament subcutaneously over the

thenar eminence to the distal end of the thumb incision. Next, the proximal end of the cut extensor brevis pollicis tendon is grasped and pulled through to the palm. Another forceps is inserted into the channel previously occupied by the tendon of the flexor carpi radialis to the point to which one has drawn the tendon of the extensor brevis pollicis in the palm; this tendon is again gently grasped and pulled through the channel to the wrist. With the thumb held in apposition by an assistant it is now sutured to the flexor carpi radialis end-to-end. The thumb and wrist are put in plaster, the thumb fully apposed, and the wrist held in slight flexion to relax tension on the sutures during healing and organization.

The after-treatment is similar to other tendon transplantations. The patient should in due course be able to pick up small articles by means of the thumb and first finger. He should also be able to write.

Fig. I.—Anterior view, showing palmar incision.

Fig. II.—Lateral view, showing thumb incision. Compare range of opponens action with below.

REPORT OF CASES.

CASE 1. G. S. W. Right shoulder, September 1, 1918. Brachial plexus lesion of median and ulnar nerves. Suture in 1919; re-explored 1920. Followed by recovery of all long muscles, but all the intrinsics remained paralyzed. I operated March 6, 1922, transplanting the extensor brevis pollicis to the flexor carpi radialis as above described (note the latter muscle has been once paralyzed). Patient can now approximate the thumb to the tips of the index and medius. He can write in the ordinary way. He can pick up small objects, such as a penny or a sixpence. His only difficulty now is that he cannot appose the pads of his fingers easily, the contact being made with the tips of the fingers. (See Figs I, II, III, IV.)

FIG. III. Lateral view, showing apposing action of thumb after operation.

FIG. IV. Anterior view, showing amount of apposition.

CASE NO. 1.—G. S. W. Right shoulder, brachial plexus injury, median and ulnar paralysis. Brachial plexus explored twice, suture and freeing. Recovery of all long flexors; recovery of median sensation; recovery of ulnar sensation. No hand intrinsics. Thumb held hyperextended; thumb held adducted. Transplantation done March 6, 1922. Can now pick up articles with thumb and fingers. Can write with difficulty, but distinctly.

Case 2. G. S. W. Right wrist, October, 1918. Median and ulnar intrinsic paralysis. Suture April 12, 1920. No improvement in voluntary power but good return of sensation. I operated July 10, 1922, transplanting extensor brevis pollicis into flexor carpi radialis in the manner above described. This patient got an excellent result, being able to appose the thumb to the index, medius, and annulus. He writes very well in the usual way; he can pick up small articles; he can button his clothes with the right hand.

THE TREATMENT OF THE FLAIL ANKLE; PAN-ASTRAGALOID ARTHRODESIS.*

BY ARTHUR STEINDLER, M.D., F.A.C.S., IOWA CITY, IA.

A NEW operative method of stabilizing the flail ankle joint is a rather hazardous thing to submit to you at a time when the excellent methods of Whitman and Davis have only recently been investigated by the Committee on Stabilization of the Ankle and have been recommended as methods of choice. The writer feels, however, that the question of operative ankylosis of this joint is not yet definitely settled, especially as regards the degree and extent of the ankylosis.

The methods of partial arthrodesis of this joint are represented mainly by Dr. G. G. Davis in his subastragaloid horizontal section with backward displacement of the foot, by which method a complete arthrodesis of the joints below the astragalus is accomplished.

The operation of Dr. Michael Hoke is a subastragaloid arthrodesis with temporary removal and reshaping of the head and neck of the astragalus, a method which has been recently described and demonstrated. A partial arthrodesis is also the method of Soule by which a fusion is created between the astragalus and the scaphoid. The complete arthrodesis is represented foremost by the method of Whitman, which is an astragalectomy with backward displacement of the foot and which results in a fibrous arthrodesis in the articulation between the mortise of the tibia and the os calcis.

A complete method of arthrodesis is that described by Dr. J. E. Goldthwait. This method consists in denudation of all joints, both supra- and infra-astragaloid, with the exception of the astragalo-scaphoid joint.

A complete arthrodesis of the ankle joint is also represented by the method of Sir Robert Jones who, in his two-step operation, arthrodeses all the joints above and below the astragalus.

The preference of subastragaloid methods for stabilization of the ankle as represented by the technique of Davis, Ryerson, and Hoke, is based on the proposition that the lateral stability of the ankle is entirely a function of the subastragaloid joint. This is no doubt true for the normal joint. In the paralytic flail ankle, however, it is by no means certain that lateral motion is carried by the subastragaloid joints alone.

*Read at the meeting of the American Orthopedic Association, held at Washington, D. C., May 1-3, 1922.

Dr. De Forest Willard, in describing a case of subastragaloid arthrodesis, mentions a recurrence of the lateral deformity, which took place, however, not by a relapse in the arthrodesed joints, but by rotation taking place in the ankle joint proper. (*Journal Orthopaedic Surgery*, 1916, 14, 327.)

Baisch, in speaking of the normal foot, mentions that in plantar flexion, the mortise of the malleoli grasps the astragalus less snugly than in dorsiflexion and that, therefore, slight lateral motion in this joint is possible. (*Zeit. Orth. Chir.*, 1913, 31, 221.)

Nové-Josserand insists in flail ankle upon the arthrodesis of the tibiotarsal as well as the subastragaloid joint. Barbarin prefers the combination of tibio-tarsal and subastragaloid arthrodesis to the mediotarsal and subastragaloid arthrodesis alone. Ombrédanne also prefers in dangle feet the so-called triple arthrodesis, namely, the tibio-tarsal, subastragaloid, and mid-tarsal fusion, while in the cavus deformity tarsectomy is preferred.

The method used by the writer is essentially a modification of the technique devised by Goldthwait, but with the extension of the fusion to all joints of the ankle excepting the articulation between the cuboid and the calcaneum. The cases which have been largely selected for the use of this method were those of drop and drop dangle foot. Most of the cases of the cavus and calcaneo-cavus deformity were reserved for Whitman's operation. The cases demonstrated will show, I believe, that the resulting arthrodesis is equal in stability to that obtained by other methods, and in addition to this it may be argued that the method described is not mutilating and that it is extremely simple in execution.

TECHNIQUE.

A U-shaped incision is made around the outer malleolus, beginning two inches above and behind the tip of the fibula and curving downward and forward, similar to the incision used in Whitman's operation. After division of the peronei and the calcaneo-fibular ligament, the joint is opened by extreme supination and adduction of the foot. The joint surfaces of tibia and fibula, as well as of the body of the astragalus, are now in view. All cartilage is painstakingly removed until nothing but raw cancellous bone is in evidence in place of the cartilage. By pulling the body of the astragalus upward the subastragaloid joint is then brought into view and this, too, is completely denuded of its car-

PLATE I. Incision circling outer malleolus.

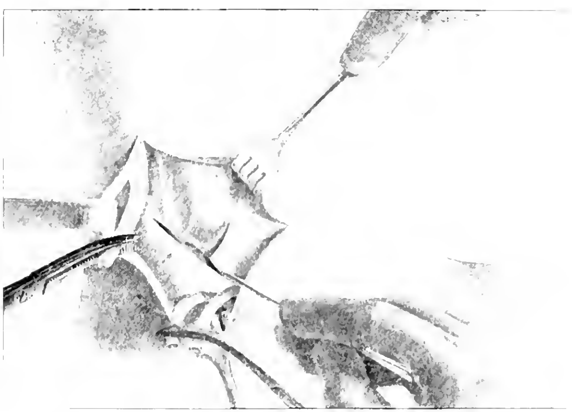

PLATE II. Cutting peronei and deltoid ligament.

PLATE III.—Denuding articular surfaces of tibia, fibula, and upper surface of astragalus.

PLATE IV.—Denuding articular surfaces between astragalus, os calcis, and scaphoid (subastragaloid joints).

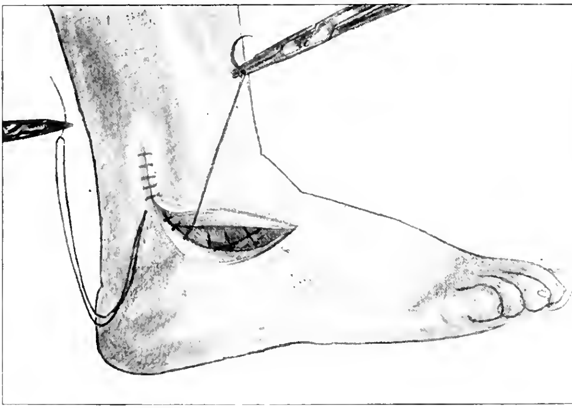

PLATE V.—Closure by layers.

tilage covering. Lastly, after division of the astragalo-scaphoid ligaments, the joint between the latter two bones is opened and likewise completely denuded of its cartilage covering. In this whole maneuver the astragalus remains attached only by its inferior ligaments. When the denudation of cartilage is completed in all joints, the astragalus is replaced and the foot is put up again in normal position. The cut ends of the peronei are reunited and the wound is closed in layers. A small gutta percha drain may be left for 24 hours to take care of the oozing. (Plates I-V.)

POSITION.

We have found that the most suitable position of the foot following operation is that of perfect lateral alignment with about twenty de-

FIG. I a.
Paralytic equino-valgus.

FIG. I b.
One and one-half years after arthrodesis.

FIG. II a.
Paralytic drop dangle foot.

FIG. II b.
Nine months after arthrodesis.

Fig. III a.
Paralytic equino-varus.

Fig. III b
Two and one-half years after arthrodesis.

Fig. IV a.
Paralytic drop dangle foot.

Fig. IV b.
One year after arthrodesis.

FIG. V.—Forty years; fusion six months after panastragaloid arthrodesis.

grees of drop corresponding to ¾ to 1 inch plantar flexion. A greater drop of the foot is not so well tolerated, even if it might seem advisable to equalize the shortening of the limb.

A plaster of paris cast applied in the position described, extending over the slightly flexed knee, remains in place from three to five months, after which time it is replaced by an ordinary strong boot.

A flail foot, not deformed, associated with a good knee or at least good or fair knee flexors, is best suited for this method.

RESULTS.

The ankylosis obtained by this method is thorough and solid and x-ray pictures show complete fusion of the joints in a large majority of cases. The gait is firm and with few exceptions, painless. The condition of

Fig. VI.—(Same case as Fig. I.) Fusion six months after panastragaloid arthrodesis.

the knee is of great influence upon the stability of the ankle. The fusion in slight equinus position has a tendency to stabilize the knee. Any residual contraction of the knee must be overcome beforehand. Any disalignment between knee and ankle, such as inward rotation of the patella, should be corrected afterwards. This latter complication calls for an osteotomy of the tibia with outward rotation of the leg above, and this measure has been applied in several cases with material improvement of the gait. (Figs. I-VI.)

REPORT.

Of 36 cases operated upon by this method, 35 were cases of infantile paralysis. The youngest patient was 17 and the oldest 40 years old. Paralysis of the ankle alone existed in 19 cases and paralysis of the ankle combined with that of knee or knee and hip, in 16 cases.

The duration of the paralysis ranged between 1½ and 39 years. The types of residual deformity were distributed as follows:

Paralytic drop dangle foot, 19 cases; paralytic equino-valgus, 6; paralytic calcaneo-valgus, 3; paralytic equino-cavus, 2; paralytic equino-varus, 5.

END-RESULTS.

Twenty-one of the cases operated upon have been under observation one year or more following operation. Four cases showed no pre-operative shortening, while in the remainder of the cases there was a pre-operative shortening ranging from one-eighth of an inch to two and three-quarters of an inch. An ankylosis of the joint sufficiently firm was obtained in practically all cases. Of four cases wearing braces before operation, one discarded the brace, while the other three retained it. All of the three cases wore braces, however, for deficiencies of the knee.

Eighteen cases walked after operation with the foot in corrected position and without brace. In two cases, the osteotomy of the tibia was added later in order to procure a proper aligument of ankle and knee.

The author feels justified in recommending this method for the stabilization of the ankle joint in cases of drop foot or drop dangle foot.

DISCUSSION OF DR. STEINDLER'S PAPER.

Dr. Michael Hoke: I appreciate Dr. Steindler's paper. Dr. Steindler is correct, I think, in stating that sub-astragaloid arthrodesis, no matter what may be the method employed, does not solve the problem of the dangle foot. The reason is that even if one stabilizes the sub-astragaloid joint, universal joint motion still remains in the ankle joint. In the dangle foot the internal and external malleoli are usually not normally developed, and do not grip the body of the astragalus sufficiently firmly to prevent lateral motion.

In the moving pictures we have seen, the patients seem to walk very well. I think we still have to decide between astragalectomy and pan-arthrodesis for dangle foot. Of course, the ideal result to obtain in dangle foot is a foot that is stable in so far as lateral motion is concerned, and yet possesses a little plantar and dorsal flexion movement. Astragalectomy would give this combination. I have not seen Dr. Steindler's cases. One of the difficulties about a medical meeting is that we are called upon to discuss things we have not examined, and impressions may be recorded that are totally erroneous because not formed from observation. I would not like to state, therefore, which is preferable—astragalectomy or pan-arthrodesis. I hope to have the opportunity of seeing some of Dr. Steindler's cases later, so that I may be able to obtain a correct comparative opinion as to which is the better operation for dangle foot.

Dr. A. Bruce Gill: Dr. Steindler's discussion of arthrodesis of the foot, together with the report of the Commission on stabilization of the foot, tends,

I fear, to confuse in the minds of many this subject of stabilization of the lower extremity. The entire matter is after all very simple.

Lateral deformity of the foot is best corrected by arthrodesis of the joint in which lateral motion of the foot takes place, *i.e.*, in the subastragalar joint. By subastragalar joint we mean the articulation of the astragalus with the os calcis beneath and the scaphoid in front, which constitutes one joint. The foot rotates about the astragalus which is fixed between the malleoli. Davis' subastragalar arthrodesis or Hoch's method of stabilization both accomplish this result. A firm and permanent arthrodesis may always be secured after the age of seven or eight years, if the operation is done properly.

If there is marked lateral unbalance of muscles, lateral play may develop in the ankle joint after a subastragalar arthrodesis. It is wise, therefore, to attempt an approximate balancing of muscle power at the same time that the arthrodesis is done.

If there is a dangle foot, *i.e.*, without power below the knee, combined with power above the knee, again the problem is simple. Stabilize the dangle foot by a Davis horizontal transverse section or by a Whitman astragalectomy. Both methods, if properly done, are absolutely efficient.

If there is a dangle foot combined with no power above the knee, *i.e.*, a flail extremity, the problem becomes more difficult. If there is power in the glutei the patient will walk quite well if we secure stability of the foot as advised above, and in addition correct contraction deformity at the knee so that the knee may slightly hyperextend when weight is put upon the foot. In young patients this hyperextension may be secured by tenotomy of the hamstrings or by forcible hyperextension under an anesthetic; in older patients or even in younger ones in whom relapse occurs, an osteotomy of the femur above the knee is necessary to secure a permanent back-knee. So often contracture of the knee is combined with a knock-knee. Osteotomy is then indicated. If there is no power in the glutei, the case is still more difficult, but the patient may be enabled to walk without a brace if we arthrodese the ankle with the foot dropped about 15 degrees below the right angle, and at the same time make a back-knee. Years ago Dr. Davis pointed out the mechanical action thus secured to stabilize the flail extremity. If in this latter condition there is lateral deformity of the foot, a subastragalar arthrodesis is to be combined with the ankle arthrodesis, and Dr. Davis did this combined arthrodesis simultaneously or at different operations, as the occasion demanded, in numerous instances.

Therefore, I think it is unwise to introduce an operation called the panastragalar arthrodesis, which includes arthrodesis of ankle and subastragalar joints. The indication for each of these arthrodeses is clear and definite, and the one is not related to the other. For certain conditions we do subastragalar arthrodesis, for another condition we do ankle arthrodesis. In a few instances we combine the two, as mentioned above. Is it not better not to confuse the entire matter by proposing an operation which in the first place is only a combination of two arthrodeses long since described and in use for many years, and which in the second place does not take into account the clear-cut simple principles enumerated above?

ELECTRICAL TREATMENT OF INFANTILE PARALYSIS AND OTHER LOWER NEURONE LESIONS.*

BY G. MURRAY LEVICK,

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OCCASIONALLY the efficacy of electrical treatment of the muscles affected by anterior poliomyelitis comes under discussion, and from what has been said both by its advocates and opponents, it appears rather as if the most important factor has escaped notice.

The actual nutrition of the muscles during their paretic period appears to be the only matter considered. Connected with this, however, is another consideration of such importance that it should be placed first of all, as it is the crux of the whole question, of which the neglect causes many of the tragic results following quite mild attacks of this disease.

This factor is the preservation of contractility in the muscles. It has been asserted that muscles cut off from their motor nerve supply may be seen to waste, even if they receive electrical treatment, but if this is properly applied, the wasting, which should be slight only, is not accompanied by loss of contractility. If no such electrical treatment is given, the atrophy is greater and is usually accompanied by loss of contractility in some degree; sometimes by entire loss, so that no electrical response can be obtained.

This can be explained by the accepted theory of muscle contraction given to us by Schaffer. When a muscle contracts, the clear contractile substance passes into the tubes of the sarcous element, which are elastic and are dilated by its entry. When the muscle is relaxed, this substance flows out of and remains outside the sarcous element, the little tubes narrowing as they elongate.

So long as the muscle remains in a state of complete relaxation, for example, when elongated during paralysis, the little tubes remain in this posture. It appears to me that the atrophy following the paralysis, besides causing absorption of the contractile substance, is accompanied by a loss of elasticity in the sarcous element, so that the tubules can no longer dilate to their proper extent for the contraction of the muscle

*Read before the British Orthopaedic Association, October 20, 1922.

in response to a stimulus. This loss of elasticity may be partial, leading to an impairment of contractility in the muscle, or if allowed to progress far enough, such rigidity is the result that dilatation is impossible and contractility is altogether lost.

The above theory is absolutely in accordance with observed facts, and it will be seen that it is a separate condition apart from the mere loss of contractile substance.

In lesions of the lower neurone these changes take place more rapidly in young children than in older children and adults, so in their case it is very needful to begin early. But in any case there is really only one way absolutely to safeguard these paralyzed muscles from this dire catastrophe, and that is to ensure a periodical contraction during paralysis, and the only way to ensure this is to employ electrical stimulation. There are no other means.

The cause of failure of electrical treatment in infantile paralysis lies too commonly in ineffective methods of application, and this leads to erroneous opinions held on the subject by those who observe the results. Treatment directed to an increase of the circulation in the affected limb yields good results up to a certain point, and undoubtedly improvement of nutrition in the limb as a whole takes place when, for instance, it is periodically immersed in a faradic or sinusoidal bath, but to show the futility of such treatment in maintaining the contractility of the paretic muscles, only one typical case need be cited.

Suppose a patient to be suffering from acute anterior poliomyelitis in the following degree. Extensor longus digitorum and extensor proprius hallucis do not respond to faradism; tibialis anticus responds very feebly, while the peronei are quite normal. The interrupted faradic or sinusoidal current is now passed through the whole limb. The muscles that most need the treatment are extensor longus digitorum and extensor proprius hallucis, and these do not respond at all. Next in order of importance comes tibialis anticus, which responds only feebly, while the peronei, which are normal and do not need the treatment, respond quite well. At the same time actual harm is done owing to the action of the peronei and the normal calf muscles which plantar-flex the ankle joint, thus stretching the paretic muscles at each surge of the current. This latter evil can be avoided if the foot is firmly splinted during treatment, but this is a difficult matter when a bath is used, and a precaution rarely carried out.

It has already been stated that wasting and loss of contractility proceed more rapidly in young children than in older patients. This ren-

ders effective treatment the more urgent in their case, especially as the limb will be increasing in length.

Passing to the application of the treatment, it cannot be too strongly urged that paralytic muscles should be treated only by operators who have learned this particular work under proper supervision in a school dominated by orthopaedic ideas. A masseuse who has passed an examination in electrology, etc., on experience gained on normal muscles or in the performance of the more usual forms of medical treatment is not ready to undertake this work. It is often a very difficult matter to pick out and exercise wasted paretic muscles, and success in the more difficult cases can be attained only by constant practice on the particular type to be treated.

A good example is that of the trapezius, paralyzed after injury to the spinal accessory nerve in an operation on glands in the neck. A case of this sort may be sent for treatment say a year after the lesion occurred. The nerve is recovering, the muscle is wasted, the lower fibers not activating. The rhomboids and levator anguli scapulae respond whenever the current leaks into them or the fifth cervical nerve during the efforts of the operator to pick up the paralyzed muscle. I believe there are very few operators who know how to coax this paretic trapezius back to the stage where voluntary exercise can be begun. Only a clever hand, practised in the treatment of this particular lesion, is likely to succeed. On the other hand, the incompetent will only increase the hypertrophy of the normal muscles mentioned, and the treatment thus proves a failure time after time.

Turning to another type of patient, I will record a case I had not very long ago, because it is so very instructive. A boy of sixteen was sent to me who had suffered from facial paralysis on one side since the age of five, the history being typical of an ordinary "Bell's palsy." When I first saw him he had slight voluntary control of his frontalis, corrugator supercilii and levator labii superioris. There was a faradic response in these but in no other facial muscles. They were so ill developed that the galvanic response was small, but clearly normal in character. It seemed evident that the lower neurone disturbance from which he had suffered originally had cleared up completely long ago, but the recovery of the nerve had never been discovered.

After a little treatment with the galvanic current, a faradic response was obtained throughout the facial muscles, and gradually day by day the muscles were exercised and redeveloped by means of this current. All attempt at voluntary movement was forbidden at first, as it only

elicited response on the opposite side, but as soon as a fair state of nutrition had been obtained in the treated muscles, exercises were begun by the patient, who was taught to "make faces" in a mirror, endeavoring to get even movement on both sides. The result was a great success. The normal creases began to appear and the boy could smile without evident distortion. The muscle presenting the greatest difficulty was orbicularis palpebrarum. He had suffered from conjunctivitis for years, owing to his eye remaining open during sleep, but even this symptom disappeared in the end.

I have come across a good many cases of infantile paralysis in which nerve recovery had been undiscovered because electrical treatment had not been sought from those competent to give it, and diminution of nutrition and contractility in the early stages of the disease had prevented recovery of tone later on. In the case of facial paralysis described above, an important factor was that the paralyzed muscles had not been greatly stretched.

It is hardly necessary to say that the relaxation of paralyzed muscles, if needful by artificial posturing, is of primary importance; far more important even than electrical treatment, because a paralyzed muscle cannot recover if kept on the stretch.

If electrical treatment cannot be obtained, the relaxation by posture should be continuous until voluntary movement has returned. The success of the treatment of paretic muscles by continued relaxation is, I think, due to the fact that little by little, as the tonic stimuli return through the recovering axons, the contractile substance is able to wedge its way back into the tubules of the sarcous elements.

This must necessarily be a slow process owing largely to the weakness of the stimulus, and should the muscle, even momentarily, be stretched, it must take many hours for the lost ground to be regained. When proper electrical treatment is being given, however, not only will the return of tone be far more rapid, but it seems to me that there can be no harm in one daily movement through the complete range of the joint crossed by the muscle, just before the treatment is given, because immediately afterwards the fullest possible contraction of the fibers can be obtained by electrical stimulus. Thus the former objection to the daily stretch is removed and much benefit derived in other directions.

It is hoped that these outlines may induce those who have been skeptical as to the uses of electrical treatment of muscles affected by lower neurone lesions, to give the matter further consideration, as it is surely desirable in all cases, so long as any recovery of the nerve is hoped for.

A CRITICAL CONSIDERATION OF CONGENITAL RADIO-ULNAR SYNOSTOSIS, WITH SPECIAL REFERENCE TO TREATMENT.

BY ALEXANDER GIBSON, F.R.C.S (ENG.), WINNIPEG, MAN.

This condition is not a very common one. It has been dealt with rather exhaustively in German literature, but the records in English and American literature are not very extensive. An admirable paper by Wilkie gives the main particulars. It is impossible to add much to his masterly presentation of the subject. In America, papers by Feidt, Kopelowitz, Painter, and Sever have also appeared. A perusal of the literature brings out clearly the fact that there is as yet no unanimity in regard to treatment of the condition. On the one hand, many surgeons are content to let the condition alone; at the other extreme may be mentioned the patient of Dawson who underwent five or six operations on the one forearm. The purpose of this paper is to discuss the question of surgical interference, and to examine what have been the results of such interference in the past. A short résumé of the subject may be of interest.

Congenital radio-ulnar synostosis has a marked hereditary tendency. Feidt's two cases occurred in mother and daughter. Dawson's occurred in brother and sister, and a maternal grandmother had shown the same peculiarity. It may be unilateral or bilateral. Two types are described, according to whether the fusion is or is not accompanied by dislocation of the head of the radius. In the former type the dislocation may be forward or backward. Most writers regard the condition as congenital, Stimson being doubtful.

In the majority of cases the radius is said to be fixed in full pronation. The inferior radio-ulnar joint is described as free. Shortening and bowing of the forearm usually occurs, and while flexion of the elbow is unimpaired, extension may be slightly limited. Movement at the carpal joints is usually more free than normal, so that a certain amount of rotation of the hand on the forearm is possible.

In regard to the important question of disability it is hardly fair to consider many of the cases occurring in childhood. Many are noticed quite accidentally, *e.g.*, in one of Wilkie's cases, a boy aged $5\frac{1}{2}$, the con-

dition had not been observed until a few months previous. In a case recorded by Painter, a girl of 11 complained of tiring easily when learning to write. Up to this time "neither the child nor the parents had detected anything abnormal."

In older subjects one notices that the disability is not incompatible with earning one's living by hard manual work, as in Feidt's case, where the patient, a female aged 42, noticed especial difficulty in wringing clothes. One of Wilkie's cases, a male aged 34, could earn his living as a laborer although possessing a bilateral synostosis; another, female aged 24, had no difficulty in ironing in a laundry. Her chief disability was in receiving change. In Kopelowitz's case, a male, 22, with bilateral fusion, no mention is made of a similar drawback in his work as a hotel porter. The position of full pronation is quite compatible with piano-playing (Feidt). Lunn's patient worked as a waitress, carrying trays on the back of her hands. From such considerations as these it is obvious that the disability, though a handicap, is by no means an insuperable one.

If operative interference is undertaken it may take place in childhood or in adult life. In favor of early operation is the fact that the younger the patient the more readily will the soft parts adapt themselves to new conditions and to new functions. Against early operation is the equally important fact that the elbow region in children is especially prone to the formation of new bone, and that however thorough the removal of bony bridges, the tendency to recurrence of the synostosis is overwhelming. Practically every case operated on in childhood has shown recurrence. Stretton in 1899 removed about one inch of the upper end of the radius, leaving only sufficient attachment for the biceps tendon. The case was not seen again until 1905, when the condition was "practically the same as before operation." Rais after division of the synostosis found the result "disappointing." Jackson Clarke's experience was that "synostosis recurred." Roth, in 1921, reported a case of operation on a boy aged 10. Discussion of this case elicited the general opinion that "no movement at the radio-ulnar joint was possible." Sever performed an osteotomy of both radii in a case of bilateral fusion, putting the forearm up in full supination, keeping it thus for six weeks, and following with a "very rigid course" of after-treatment. His conclusion, in spite of recurrence of the synostosis on one side, is that both arms were "more useful." The evidence adduced in this case is probably more convincing to the operator than to a stranger. Strenuous passive movement of the elbow region is emphatically contraindicated after injuries in children. Impartial consideration of the reports leads

one definitely to the conclusion that in children removal of the bony bridge with or without resection of the head of the radius is a mistake. Osteotomy of the radius as exemplified in Sever's case does not provoke enthusiastic encomiums. It is suggestive that "long-distance" reports after operation in childhood are not forthcoming, although ample time has elapsed for their appearance.

Is operation worth while in adults? Perhaps no case has had the benefit of more thorough surgical treatment than that recorded by Dawson. The patient, a female aged 33, underwent no fewer than five operations on the one forearm. The bony bridge was first divided; the second operation consisted in "freeing the head of the ulna"; the third operation was "division of the interosseous membrane from top to bottom through a straight incision down the flexor surface of the forearm." When as a fourth measure excision of the head of the radius was performed, "it was found that some slight bony reunion had taken place between the cut surfaces of radius and ulna where the original bridge of bone had been removed." Evidently then recurrence of synostosis is not limited to childhood. Although a considerable measure of improvement had been obtained, the patient was not satisfied and accordingly under a fifth anesthetic there was carried out "osteotomy of the radius through an incision seven inches long" at the junction of middle and lower thirds of the forearm. The fragments were secured by a plate and screws. Presumably a sixth operation would be necessary for removal of the plate. Dawson at the date of writing (1912) thought the result had quite justified the procedure. At a discussion on the subject at the Royal Society of Medicine in March, 1913, the general opinion was that the result was poor compared with the amount of work done. From the esthetic point of view alone the scarring of the forearm must be sufficient to brand this case as at least an incomplete success. It is significant that although the condition in Dawson's patient was bilateral there has been no report of operation on the other arm, although ten years have elapsed; and further that, although a younger brother in the same family has the same disability, there is no report of operation on him.

It should be remembered that in adults the soft parts must be adapted strictly to the position of pronation which has existed since birth. Dawson at operation found "no trace of the supinator brevis muscle." The pronator quadratus muscle is bound to be very much shortened, and all the muscles of the forearm, flexors and extensors, must be strictly accommodated to the bony conditions under which they have worked for years. Further, the cortical representation of the movements of prona-

Case 1.—D. H.

Case 2.—A. J. O.

tion and supination must be present in an undeveloped condition, if present at all. Even granting that anatomical conditions were modified to permit of passive pronation and supination, it is far from likely that active movements would be possible until the lapse of considerable time.

Is interference ever justifiable? If it be assumed in any one case that radio-ulnar fixation is inevitable, the next consideration is, "Which is the best position for such fixation?" Full supination is certainly not the optimum position; full pronation is probably not so good as the mid-position. An osteotomy to bring about this change of position from full to semi-pronation is probably justified in some cases. For the most part the patient is not likely to lose much if left alone.

Subjoined are notes of two cases which have come under the writer's care.

D. H. Aged 2, female. Condition noticed about one week ago by a friend. Examination of upper limbs shows a congenital synostosis of right superior radio-ulnar joint. X-ray shows fusion of the head of the radius to the ulna without dislocation. The forearm is definitely shorter; the radius is no stouter than on the opposite side and is definitely bowed. The ulna is slender and is also shorter than the left ulna.

A. J. O. Aged two years and nine months. Mother thinks the left arm is "not right." First noticed about two months ago. X-ray shows congenital synostosis of the bones of the left forearm. Both bones are shorter than on the opposite side. The ulna is definitely more slender while the radius is stouter and more bowed.

In neither case is there a hereditary or family history. In regard to both patients a waiting policy was pursued.

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BONE BLOCK AT THE HIP JOINT.

BY WALTER TRUSLOW, M.D., F.A.C.S., BROOKLYN.

AMONG the most brilliant achievements of orthopaedic surgery is the detection and elimination of body disabilities due to bone block in joints. As the writer uses the term, bone block is a condition in a joint whereby one or more of the movements normal to that joint are limited solely by the presence of a bony outgrowth at or near the joint. (See Fig. 1.)

FIG. 1.—F. G., chauffeur. May 24, 1921. Old fracture of neck of femur 11 years previous, leaving a traumatic coxa vara with exostosis on upper surface of neck, and limiting abduction (at 12 deg. adduction).

The causes of such adventitious outgrowth are various. Bone block does not include ankylosis or partial ankylosis found in a joint actively inflamed by the lesion of any infection; although the outgrowth of bone

tissue, due to such infection long since healed, may constitute true bone block. Bone block also may result from the faulty union of fractures near or involving a joint.

The presence of the blocking bony excrescence can often be discovered, or at least definitely suspected, by carefully studying the case history and by thorough clinical examination. In the examination, the characteristic feature is actual and complete stopping of the moved segment before the normal range of motion is reached; and the stoppage is in one direction only, or in directions associated each with the other, whilst motions in other directions may be unlimited. Also passive motions are made with little or no pain to the patient. This, of course, differentiates bone block limitations of motion from those found in acute inflammatory conditions; as in the latter, passive motions are more or less limited in all directions and are usually made with pain. The x-ray study usually elicits the presence and the location of a blocking growth, although views in different directions or by stereoscopic exposures may be necessary.

The surgeon may be consulted simply because of disability due to lessened range of motion; but it is more usual that the patient complains of pain. If there is pain, it is found that it is present on using the joint, and ceases, or is greatly lessened, when the joint is at rest. The pain may be due to direct and constant impinging of unduly approximated bony points upon each other, or possibly the buckling in and pinching of soft parts between bones; or it may evince itself as a strain more or less distant from the joint involved and due secondarily to muscles unduly stressed in attempting to accommodate the body to the unbalances caused by the incompleted movements of the blocked joint.

Whatever may be the disability, pain or strain, the patient seeks relief, and the surgeon, skilled in the problems of deranged joint mechanism, must weigh carefully the disabilities and the possibility of mechanical compensation or of operative elimination of the bone block cause, for true bone block does not cure itself, although much compensation for its disabilities may often be attained.

It is because these problems are sometimes difficult and operative results of doubtful benefit, as applied to the hip joint, that the writer presents a brief analysis of two cases of bone block at the hip joint upon which he has operated. When operative treatment is decided upon it is often possible to change the carrying or weight-supporting angle of a long bone, near the joint, in such a manner as completely to compensate for the blocked motion in the joint and a good result is obtained. This,

of course, eliminates the danger of even greater loss of function which may result from entering the joint proper. As exostoses, when found about the hip joint, are usually located at the edge of the femoral head, as in Case I, here presented, or at the rim of the acetabulum, as in Case II, it can be eliminated only by entering the joint. And as bone block at the hip joint does not conform strictly to the definition here set forth, in that some limitation to most of the normal motions is found, an extra-articular osteotomy with determination of a new angle would not meet the requirement of resulting free motions in all directions. The writer questions whether the intra-articular operation, as evidenced by the results obtained in his own cases, warrants the time and expense to the patient, even when the blocking bone was apparently entirely eliminated.

Case I. Old fracture at junction of head and neck of femur resulting in coxa vara, with bone exostosis on the upper margin of the neck of the femur, which by impinging upon the adjacent lip of the acetabulum, resulted in adduction deformity and one inch shortening with much pain.

Chauffeur, 38 years old. At nineteen years of age, fell from and dragged by a sleigh, fracturing the left hip. In bed seven weeks; one year on crutches. Always pain, ever since, on walking. Pain referred to upper outer thigh. On examination, it was found that the upper end of the thigh bone, on the affected side, was very prominent; on walking, upper end of femur moves upward and forward with each step. In prone lying, affected trochanter one-half inch above opposite side. The affected thigh could be flexed 75 degrees, could be over-extended 10 degrees, was prevented from abducting at 10 degrees short of the neutral position, adduction was unlimited and rotation was almost nil. Where limitation of motion, in any of these directions, was reached, it was with practically no pain to the patient, but with a distinct sense of sudden stopping, like that of the normal extension of the elbow. The x-ray (Fig. 1) showed an old healed fracture through the base of the head of the femur with the head displaced downward (or the neck displaced upward)—a traumatic coxa vara—and with a bony outgrowth on the upper margin of the neck of the femur, so placed as to impinge upon the upper rim of the acetabulum, even when the thigh was in adduction.

This was a case of true bone block, distinctly limiting much of the hip motion, and by mechanical disadvantage and by pain, greatly interfer-

ing with the man's work. The only mechanical aid which could be suggested was that of raising the sole and heel to compensate for shortening. He had done this himself; but pain and disability, though lessened, were still a burden to him. He was very willing to consider operation. A Ganz operation with new abduction position of thigh was rejected because motions other than abduction were limited. Intra-articular operation was performed in June, 1921. The U-shaped lateral incision, with approach to the joint by turning back of trochanter major and its muscular insertions was used. It was comparatively easy to chisel off the extra bony mass on the upper border of the neck. Then there was a cuneiform osteotomy of the neck of the femur. After reposition of the trochanter and closure of the wound the limb was put up in plaster of Paris dressings, from the waist to the toes, in abduction.

While in the hospital, on the third day, he managed to tear away the plaster of Paris dressing over the opposite side of the pelvis, and when found the next morning, he had a smile on his face and a complete return to adduction position. Although it was explained to him that it was not improbable that he had thus destroyed the usefulness of the operation, it was not possible inside of three weeks to get consent for the re-application of plaster dressings in abduction position.

All dressings were removed nine weeks after the operation, and the patient was advised to use the part as much as possible. The use of the bicycle aided this.

Examination in April, 1922, ten months after operation, showed:
A limb shortening of 7½ inches—One-half inch increase.
A. G. F., 128 degrees—23 degrees more limitation.

All other motions, especially the disabling limitation to abduction, were increased as follows:

A. G. E., 20 degrees over-extension—10 degrees more motion.
Abduction, 20 degrees—32 degrees more motion.
Adduction, 5 degrees—No change.
In-rotation, 8 degrees—8 degrees more motion.
Out-rotation, 12 degrees—12 degrees more motion.

This gives a total of 39 degrees more motion than before operation, and the patient is now without pain and back at his work as chauffeur. But there is less flexion than before operation, now only 52 degrees, and

one and one-half inch shortening, one-half inch more than before operation. These unhappy results are undoubtedly due to his willfulness in removing part of the plaster and not allowing it to be re-applied until three weeks afterward, thus destroying the angle obtained by osteotomy of the neck of the femur and correction in the abduction position.

FIG. 2.—One year after removal of limiting exostosis. He could then abduct thigh 20 deg. (a gain of 32 deg.).

The last x-ray (April, 1922, Fig. 2) shows clearly the reason for the increased shortening and the lessened flexion. There appears to have been added to the original deformity, subtrochanteric fracture with fixed upward riding of the shaft. The only useful result obtained is due to the complete removal of the exostosis at the neck of the femur. The writer frankly believes the mechanical deformity is but little better than before operation, though the resulting absence of pain may have warranted the operation.

Case II. Old intra-pelvic fracture of the acetabulum, with half-inch

FIG. 3.—Mrs. C. Feb. 28, 1921. Exostosis on lower lip of acetabulum, limiting adduction of thigh (at 10 deg. abduction).

bony protrusion on the lower lip of the acetabulum, preventing adduction by impinging of neck of femur on the elongated acetabular rim; with much pain.

Mrs. C., 55 years of age, of sedentary habits. At ten years of age, fell from a horse, "hitting the knee." Apparent recovery. At seventeen years of age, severe attack of "rheumatism," which affected the hip. It was "burned" a number of times and was much better for two years. Gradually worse since nineteen years of age. Osteopathic treatment seven years ago; some relief at first. None for past year. Now pain on sitting and on getting up. Can walk half a mile, but good for nothing rest of the day. On examination, there was found to be one-half inch apparent shortening, on placing the limbs parallel, but none on placing both in fifteen degrees abduction. There was distinct atrophy of the affected thigh.

FIG. 4.—Mrs. C. One month after removal of limiting bone block. She could then, and a year later, adduct thigh 15 deg. (a gain of 25 deg.).

Hip motions:

A. G. F., 85 degrees (95 degrees flexion); A. G. E., 160 degrees (20 degrees of flexion); abduction, only 18 degrees; adduction limited at 10 degrees of abduction; rotations limited, especially in-rotation.

The first x-ray showed to the observers, including the writer, no sign of the intra-pelvic fracture, but an outward extension of the lower lip of the acetabulum, impinging clear to the middle of the lower border of the neck of the femur, was very evident. Mechanical disability was scarcely noted by the patient; pain was said to be great, perhaps exaggerated.

No mechanical apparatus appeared likely to offer relief. Nor was an extra-articular osteotomy with reangulation of the femur considered adequate to relieve all of the joint motion disabilities. Direct removal of the protruding lower rim of the acetabulum was decided upon.

Operation was performed in March, 1921. Anterior incision; the joint capsule reached by separation between the sartorius and rectus femoris

muscles; section of capsule; although most of the protruding bone had to be removed by finger guiding the chisel, the redundant bone was apparently entirely removed—in two pieces, one, one inch long, and one three-quarters inch long. There was no plaster of Paris fixation of this limb. There was primary union of the wound, and passive motions were begun in one month.

The pain of this was greatly complained of by the patient, who was much depressed in mind. Passive motions were continued, however, and the patient urged to walk and do simple active motions.

After one year (March, 1922) the examination showed no shortening; flexion, 90 degrees—5 degrees better; extension to ten degrees of over-extension—30 degrees better; abduction, 18 to 20 degrees—about as before operation; adduction, 15 degrees—25 degrees better; rotations, practically unlimited, whereas there had been much limitation of rotation. The x-ray (Fig. 4) shows complete removal of the blocking bone on the inferior margin of the acetabulum.

There is a decided neurotic element in this patient. Mechanically and by x-ray, she has greatly increased motion, total 135 degrees increase, and there seems to be nothing to cause strain in standing and walking, but if one can judge by her statements, she has little less pain and her range of walking, without being "all in" for the rest of the day, is no better than before operation.

Conclusions: Wisely planned and skillfully executed operations for bone block at joints often result in greatly increased mechanical usefulness and in relief of pain. It is questioned whether this is frequently the outcome of operations for bone block at the hip joint. Of the two cases analyzed, the one for abduction block and for the relief of pain, the pain was relieved and a total of 39 degrees more motion was obtained, but there was an increase in shortening and 23 degrees less flexion; and the other case for adduction block and for relief of pain, resulted in a total increase in motions of 135 degrees and a very doubtful relief of pain. In both, the specific bone block sought was permanently removed and it is to be noted that both were complicated by conditions unforeseen—the man by removing his plaster dressing on the second day and thus causing a loosening of his osteotomized fragments with bad displacements, and the woman in that a neurotic habit prevents the proper judging of the subjective result of pain.

THE PATHOLOGY AND TREATMENT OF TUBERCULOSIS OF THE HIP-JOINT.

BY JAMES K. YOUNG, M.D., F.A.C.S., PHILADELPHIA.

In considering the pathology of tubercular osteitis, many surgeons proceed directly from the initial stage to ankylosis, oblivious of the well-known law that tuberculosis may terminate at any stage of its course and forgetting that the steady, onward progress of this disease is often caused by inefficient or inadequate treatment, due to neglect on the part of the parents or attendants, or to lack of proper control and frequent checking up, or to reinfection. This occurs especially in hospital cases, although it also occurs in private practice.

Some, considering ankylosis the ultimate goal, endeavor to hasten this end by fixation, without traction or by operative measures.

A similar logic is applied to injuries to joints in laboring classes and in war injuries, where a quick recovery with ankylosis is accepted as a satisfactory result, so that an employee may be returned to his work with less loss of time.

The problem here should be different: a *movable* joint after the inroads of tuberculosis should always be the ultimate aim. If, through inadequate or inefficient treatment or neglect, ankylosis should occur, the result will be equivalent to failure, but in private practice a large proportion of patients will be restored to health with movable hip-joints.

It is erroneous to assume that all joints are similarly affected by disease, since the effects of disease vary with the joint construction, and the hip-joint is unique, in that it stands alone in its pathology.

As has been often remarked, the upper epiphysis and nearly all the femoral neck lie within the capsule of the joint,—and it thus differs little from other epiphyses,—the result being that its blood supply is derived from vessels running along the ligamentum teres and from the vessels in the reflected parts of the capsule and the investing synovial membrane, as well as from vessels that pierce the marginal and epiphyseal cartilages. For a large bone of such texture, such a blood supply is indeed slight. This epiphysis is the most isolated of all the epiphyses.

Nichols notes that:[1]

"In the long bones the disease, as a rule, begins in the epiphysis.

"Tuberculous disease of the joints is, generally if not always, secondary to the disease in the epiphysis in the adjacent bone.

"Hip disease frequently begins in the acetabulum."*

After a thorough pathological investigation of the specimens from his orthopaedic clinic, Allison[2] has come to the same conclusion as to the osseous origin of tuberculosis of joints and the later extension to synovial membrane.

Lovett[3] has expressed himself in favor of the osseous primary origin of tuberculosis of the hip-joint, which he regards as fairly demonstrated.

Since few specimens of tubercular hips are available for laboratory purposes, the pathology can be investigated by means of the rays.

Such photographs are taken at intervals from the same individual and a comparative study is made with plates taken from other persons. The roentgen rays are invaluable in determining the location and the extent of the lesion.

The most frequent form, the femoral, may be followed by the earliest rarefaction of the epiphyseal line to complete destruction and dislocation of the femur.

The acetabular form exhibits, at first, rarefaction of the acetabulum, which deepens if treatment is not adequate. The head becomes eroded and flattened, fitting into the irregular cavity, or the superior portion of the acetabulum disappears from pressure and absorption, presenting the so-called "traveling acetabulum."

If the head, after being in close contact with the cavity of the acetabulum, is dislocated by force, it subsequently dislocates upward, and the head being completely absorbed, we have the upper extremity of the femur extending some distance up above the femur cavity and resembling the pathological entity seen after an acute epiphysitis in its last stage. A clouding of the negative over a joint usually indicates involvement of the soft parts, primarily or secondarily.

Primary synovial infection without osseous involvement is difficult of demonstration in roentgenograms.

A uniform cloudiness of joints without any demonstrable osseous

*In a series of one hundred consecutive cases of excision of the hip-joint for tubercular osteitis, Wright reported ten where, in his opinion, the acetabulum was primarily diseased. ("Hip Disease in Childhood," G. A. Wright.)

structure may be considered as synovial, but sooner or later, in my experience, rarefaction of either the epiphyseal or diaphyseal line of the femur or acetabulum will be present, and if so, synovial infection without osseous involvement (if it occur) must be rare.

As previously stated, roentgen photographs should be taken at intervals of from one to three months and at varying angles, and a comparative study made from plates taken from other patients suffering with the same disease.

The beneficial effects of fixation and traction are revealed in the x-ray plate, through the increased space occupied by the cartilaginous surfaces of the head of the femur and the acetabulum, and also by the smoothness, as compared with the roughened acetabulum, indicative of the unchecked inroads of the disease.

Traumatic synovitis may occur in an individual, where there is a predisposition to tuberculosis, or where this predisposition does not exist.

In the former, recovery is prompt; in the latter, *slight* injury or overstrain produces a stasis in the normal circulation of the cancellous tissue of the epiphysis, and the tubercle bacilli lodge in the end-arteries, and rarefaction begins.

Tuberculosis of joints is, I believe, always secondary to lesions in other organs. The primary focus of infection may be difficult to locate, but painstaking effort will usually reward our efforts. The importance of this thought becomes one of the first magnitude, when we reflect that the disease is hopeless of cure if reinfection is steadily progressing.

Every effort to discover the primary lesion should be pursued with avidity. Starting with the patient's family history, every factor, no matter how apparently trifling, should be thoroughly investigated. Any suspected focus of disease, be it in the tonsils, the teeth, or in the nasopharynx should be removed. In cases of cold abscess, the exploratory puncture and laboratory examination, including injections into the guinea pig, should always precede the evacuation. A differential study of the *other* joints should be carefully undertaken. Has the patient an infective arthritis, a Charcot joint, an incipient osteo-arthritis? Tuberculin tests, local and general, should not be neglected.

Traction and fixation furnish the most satisfactory method of treatment. If the treatment is adequate, absorption of the head is prevented and the rarefied areas of the acetabulum gradually fill in with lime

salts. In the incipient stage, from absorption of lime salts, we find rarefaction of the epiphysis, of the acetabulum, or of both.

Traction and fixation is the best treatment in private patients and in those under perfect control of the surgeon. This treatment is divisible in three parts.[4]

(a) Bed traction.

(b) Traction fixation splint.

(c) Convalescent traction splint.

Bed Traction is employed for a short time only,—that is, while the first brace is being made. Any deformity of the hip or any acute exacerbation would require bed treatment.

The traction fixation splint for the first year consists in a posterior bar-brace, made over a cast of the body and extending from the fifth dorsal vertebra down to and including the foot. The pelvis, the thigh and the calf portions are constructed of hardened leather, celluloid or reinforced canvas, the first of these being the best. Two peroneal straps are employed and traction is obtained by means of an anklet and tapes, which pass down through the foot-piece. The foot-piece is always made a half-inch longer than the sole of the foot and provision is arranged for the extension of the brace as the child grows. The foot-piece prevents lateral movement in the hip-joint and this is most important.

As the acute symptoms subside, the x-rays will reveal a re-deposit of lime salts, the joint exhibiting a complete range of motion. At the end of about one year this brace is removed and a convalescent brace is applied.

The convalescent brace is made up of a pelvic band, an outside bar with a free joint at the hip and ankle, and a lock-joint at the knee.

The foot-piece is made longer than the leg, so that when the peroneal straps are adjusted, the foot is free from the foot-plate and the patient is suspended by the peroneal straps.

The patient discards the patten and crutches and wears ordinary shoes. This brace is worn about a year, at the end of which time recovery is usually established. When the convalescent brace is applied,

*It is difficult to realize at this time that in the 80's the discussion between the question of fixation or of motion was acrimoniously argued. Toward the close of this controversial period, Stillman ("Modern Treatment of Hip Disease," Geo. H. Davis, 1891) found that while almost all leading orthopedic surgeons used bed traction in some form during recumbency, when apparatus was applied permitting of locomotion, five employed fixation without traction, as compared with fourteen who employed traction apparatus of some kind.

Since 1884, I have constantly and consistently advocated combined fixation and traction in tubercular osteitis of the hip.

the day brace is used at night for two or three months, so as to prevent flexion of the limb at night. The brace is not used for *deformity* of the hip. If deformity occur, the patient is put to bed and bed-extension is applied, or the hip must be placed in proper position. However, after the brace is applied deformity *seldom* occurs. The progress of convalescence is studied by the x-rays, as previously described.

Constitutional treatment forms an important adjunct in the management of the case. Calcium salts, in some form combined with thymus gland, is at present the most rational drug therapy. Improved diet and good hygienic environment should not be neglected.

One thing should not be forgotten and it is this: If conservative treatment is instituted early and efficiently carried out, operative procedures will be less frequently required. But there will always be, in neglected cases or where treatment has been inefficient or inadequate, individual cases where operative measures must be employed.

The results of treatment with the author's splint are:

1. A diminished number of abscesses.
2. A shorter time required for cure.
3. Perfect recovery.

Now what constitutes a *complete* recovery? The writer believes the recovery should be so perfect as to form and motion, that the previously affected member cannot be detected by inspection and manipulation. The patient should also be able to take the tests suggested by Sayre, of New York,[5] and previously illustrated by the writer.[6]

Having reviewed in detail the conservative methods of treatment, we now will consider the operative treatment.[7] Operative measures are demanded for (a) the deformity and are also required (b) in the treatment of the arthritis. For the relief of deformity we include forcible straightening and osteotomy.

Forcible straightening by itself is often sufficient for the relief of the abduction and flexion deformity during the progress of the disease, if applied at the right time and in the proper manner. Where there is false ankylosis this is all that is required. The patient should be completely anesthetized and the hip may, by a single movement, be brought into its proper position. This should not require much force. If force be required it is better to perform a tenotomy of the contracted muscles, although this is rarely required.

Under no circumstance should the hip be manipulated or rough handling form part of the preliminaries. Buck's extension should be applied

FIG. 1. Forcible correction for hip deformity. Before operation, June 23, 1920.

from the middle of the thigh down, before the patient is anesthetized. This should be covered with a bandage, and a spica of the hip should be applied while the patient is still under the anesthetic.

A moderate amount of extension should be applied to the limb for two or three weeks, after which the patient may resume the convalescent hip splint. This correction should not be attempted by anyone who is not thoroughly familiar with the treatment of this condition, and the greatest care should be taken not to injure the hip.

Properly performed, this operation is often followed by prompt recovery. The rarefaction in the bones becomes filled with lime salts, the head of the bone continues to grow, and the parts being in their normal relations, according to Wolff's law, are restored to their normal condition.

An excellent result of the beneficial effects of forcible correction is shown in the accompanying illustrations.

The first x-ray, taken June 23, 1920, shows a relapse or exacerbation; the patient walking with a limp and the examination showing marked

FIG. 2.—Forcible correction for hip deformity. Four months after operation. October 5, 1920.

abduction with apparently elongation of the limb and complete limitation of motion. The spica, which was applied at the time of operation, was removed three weeks later, the traction having been continuous and the convalescent splint again applied. (Fig. 1.)

The second x-ray was taken about four months later and showed the femur in good position. The rarefaction of the acetabulum had disappeared and convalescence subsequently established. The patient had normal range of motion and walked without a limp (complete functional and anatomical restoration of the joint). (Fig. 2.)

The first photograph (Fig. 3) of the child shows the splint for the active stage. The second illustration (Fig. 4) shows the convalescent brace, and was taken after forcible reduction.

Osteotomy gives very satisfactory results in osseous ankylosis, and the Barton or intertrochanteric operation is productive of the best results. After osteotomy has been performed, the limb is ankylosed in a corrected position and motion cannot be expected. In cases of double ankylosis of the hip, after osteotomies have been performed, the limb should be set in an extended position and not in a flexed position.

FIG. 3.—Author's fixation-traction hip splint.

FIG. 4.—Author's convalescent hip splint.

Under surgical operations for arthritis we include: aspiration, incision, erasion, and excision.

Aspiration offers little of curative value, but has a diagnostic value. Puncture as a diagnostic aid in tubercular abscesses has not received the attention that it has always merited and to which the writer has called special attention.[8] For this purpose a small syringe is required and the puncture should be made on the periphery of the abscess, a day prior to the contemplated operation, and the fluid removed for laboratory examination.

The surgeon varies his operation according to the nature of the fluid that has been studied by laboratory technicians. If the fluid be sterile, incision and curettement are indicated. The presence of pyogenic organisms in the aspirated fluid demands antiseptic treatment and drainage. Tubercle bacilli, in addition to pus organisms, call for incision,

curettement, carbolic acid, alcohol, and drainage. After incision of the abscess, the part should always be put at rest with fixation and traction.

Erasion of the joint, as practised by Willard, is of value in children and where the inroads of the disease are not extensive. The diseased parts should be located with the rays and removed with a curette, flushing with a hollow spoon, employing a solution of bichloride of mercury. Abscess cavities and disease tissue should be thoroughly removed, because partial removal may be followed by tubercular meningitis.

This operation may be repeated in children and the results are satisfactory as a substitute for excision. Recovery frequently occurs without marked deformity.

Conservative treatment has greatly lessened the frequency of *excision* of the hip-joint, so that it is now seldom employed as a surgical procedure. When excision, however, is demanded it should be done as expeditiously as possible so as to conserve bodily heat and thus obviate shock.

In former years, excision was a favorite operation, and Wright of Manchester, England,[9] who recognized the epiphyseal origin of the lesion, in an elaborate table of one hundred consecutive excisions which he performed between September, 1881, and July, 1886, presents a veritable store-house of scientific treasures in his studies in the gross surgical pathology of coxalgia.

The operation is now seldom seen in hospital practice, and I know of but two cases in private practice where resort to it was found necessary.

The question of *amputation* of the hip in tubercular hip-joint disease occasionally arises where the ilium is extensively involved in addition to the disease process in the femur. If, after mature thought and deliberation, the surgeon concludes that the patient will not survive the operation, such operation should, in my judgment, be declined.

When the disease extends down the femur without much acetabular involvement, there is seldom, or ever, any necessity for amputation of the joint.

A moot question, that is much in doubt and much discussed, is "Shall we curette the sinuses in hip-joint disease complicated with albuminuria?" In my experience, decided improvement often follows curettement, as well as improvement in the renal condition.

As a brief conclusion, I would summarize these important data:

1. Few specimens of tubercular hip are available for laboratory examination, so that one need study the pathology of the affection from a series of x-ray plates.

2. Moderately severe injuries are more favorable to the development of the disease.

3. Tuberculosis of the joint is usually secondary to disease in the epiphysis.

4. In the hip-joint, the disease usually begins in the epiphyseal line of the femur and later extends to the joint.

5. Or the disease may begin in the acetabulum and extend to the joint.

6. Hip disease is usually, if not always, secondary to a lesion elsewhere in the body.

7. Fixation combined with traction affords the best method of treatment.

8. Constitutional treatment should not be neglected.

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THE VALUE OF THE ROENTGEN RAY IN THE DIAGNOSIS AND PROGNOSIS OF SARCOMA OF THE LONG BONES.*

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ONE of our principal aids in diagnosis and prognosis of sarcoma of the long bones is the roentgenogram revealing the location, size, and, to a certain degree, the structure of the tumor, but most important, early evidence of metastasis to the lung. My own experience, however, leads me to believe that roentgen-ray diagnosis of sarcoma is, at times, dangerous, particularly if the surgeon depends on such data in determining the fate of an extremity. Information concerning the type of tumor, its location and extent, the probable percentage of malignancy, and the presence or absence of demonstrable pulmonary metastasis should, if possible, be included in the roentgenographic report. Roentgenographic examination of the chest should be a routine procedure in all cases of tumor of the bone suspected of being malignant. Whenever possible, before sacrificing an extremity the tumor should be explored, with tourniquet applied, and the tissue examined microscopically to confirm the clinical and roentgen-ray diagnosis.

Thus far the medical profession has been unable to solve the problem of sarcoma of the long bones, largely owing to early pulmonary metastasis. Local excision in early cases, without evidence of pulmonary metastasis, would appear almost ideal, were it not for the local recurrence, and, still later, metastasis. More radical surgery, such as amputation, while less likely to be followed by local recurrence, has done little more than to relieve the patient of the tumor, and to permit temporary freedom from discomfort. Yet this temporary benefit seems justifiable, and at present appears to be the only certain means at our disposal of eradicating the local growth. However, amputation should be performed only when the diagnosis has been definitely confirmed by exploration and microscopic examination. Treatment with radium, the roentgen ray, and Coley's toxin, appears to be beneficial in the control of certain malignant lesions of the bone, but thus far none of these aids has proved adequate.

*Read before the American Orthopedic Association, Washington, D. C., May, 1922.

Every injury to the bone or suspected lesion should be examined roentgenologically. By the more common use of the roentgen ray in diagnosis and by constant reiteration of the danger of sarcoma, the public and the medical profession will realize the importance of early diagnosis in sarcoma, and the results thus may gradually become more satisfactory. Watchful waiting should be condemned. Unfortunately, many patients seek medical aid long after the lesion should have been recognized as a menace, and when it is clinically evident that the growth is malignant often metastasis has already taken place.

The term "central" or "medullary sarcoma" is used to designate the sarcoma confined to the substance of the bone. It usually occurs in the cancellous bone, and may extend outward evenly in all directions, or it may destroy cortex and periosteum at one side, bursting outward and rapidly invading the periosseous tissues. The borders of such central sarcoma are usually hazy, single rather than multilocular, hardly resembling the more or less well defined outline seen in cysts of the bone, osteitis fibrosa cystica, giant-cell tumors, and chondromas. The body of the tumor found in the central or medullary types may cast a slight shadow or none at all, showing a clear, almost cyst-like structure, due to absence of lime salt, bone, and so forth. Certain forms of sarcoma, however, appear to cast a shadow even more dense than the adjoining bone itself. The striations and trabeculations seen in osteitis fibrosa cystica and chondroma are less commonly associated with central sarcoma. Central sarcoma, confined to the bony substance, should be more amenable to surgical treatment than sarcoma already invading the soft tissues, yet pulmonary metastasis may occur even in the early cases and it is well to attempt exclusion of metastasis by roentgen ray in all cases. It would then appear rational to attempt local excision, radium, and later bone grafting, though in my experience such procedure has not been very satisfactory.

In the term "periosteal sarcoma" are included sarcomas arising from or apparently principally involving, the periosteum. Thus a central sarcoma may be diagnosed by the aid of the roentgen ray, and on further examination prove to be periosteal. The differentiation is not always clear, especially from the roentgenographic appearance, and is often impossible until operation is performed, or postoperative dissection is made of the specimen. While appreciating the possible danger of involvement of the soft tissue (periosteal) by sarcoma, I doubt the accuracy of the classification, at least from the roentgen-ray findings. If patients are seen early the differentiation of periosteal and central or medullary sarcoma may usually be made roentgenographically, though the evidence is of doubtful value, malignancy and benignancy, and oper-

ability with relation to metastasis being the vital consideration. The type of periosteal sarcoma showing radiating lines at right angles to the shaft, or from the point of origin, is one of the most characteristic of all sarcomas of the bone, and makes possible an almost certain diagnosis from the roentgen-ray findings alone. However, inflammatory changes often simulate the roentgen-ray appearance of sarcoma so closely that diagnosis may be difficult without exploration and microscopic examination. Periosteal sarcomas rapidly invade the soft tissues in all directions, destroying the cortex, and extending through it into the medulla. Certain types of periosteal sarcoma cause an increased density, while others cast dim shadows or none at all in the body. They may produce flakes of bone in the periphery, which are frequently to be made out in that roentgen-ray, and egg-shell crackling is felt on firm palpation.

Occasionally sarcomas, apparently arising from periosteum, resemble, roentgenographically, osteochondromas. They may involve both cortex and medulla, and extend into the periosseous structures as pedunculated tumors, casting shadows of varying density with linear markings radiating into the tumor from the pedicle, and with a bony deposit in the margin of the tumor. A denser sarcoma has been observed resembling exostosis roentgenographically, with an irregular, well-defined border.

Marked destruction of both cortex and medulla without apparent early periosseous invasion has been observed, the condition somewhat resembling syphilis, or a diffuse, low grade osteomyelitis.

If patients have been operated on previously, the interpretation of the roentgenogram as to malignancy and benignancy is especially difficult. I have observed cases of postoperative infected sarcomas and benign lesions of the bone in which the interpretation was practically impossible.

SUMMARY.

The roentgen ray is one of the most valuable, if not the most valuable, aid in the diagnosis and prognosis of sarcoma of the long bones. It reveals the location, size and extent, and to a certain degree, the structure and origin of the tumor and the presence of metastasis. It is the earliest aid in determining the presence of pulmonary metastasis, although the absence of demonstrable lesions does not mean that metastasis has not occurred. Roentgenograms of the lungs should be made as a routine measure in every case of suspected malignant tumor of the long bones, particularly if surgery is contemplated for removal of the primary tumor.

Various types of sarcoma, central or periosteal, with marked differences in density, structure, and location may be observed roentgenographically. The roentgenographic appearance of these types, while not always characteristic, is, nevertheless, fairly characteristic and yields a high percentage of accurate diagnoses. Operation should seldom be resorted to, and amputation never, without exploratory operation with the use of the tourniquet, and microscopic proof of malignancy. There may be exceptions when the member or joint is already so far involved that it is obvious that the extremity cannot be saved.

While the roentgen-ray examination is a valuable aid in diagnosis, the history and clinical findings and, whenever possible, exploration of the tumor, and its gross and microscopic appearance must be considered in determining the diagnosis, prognosis, and treatment. The prognosis, always grave, is hopeless with definite pulmonary metastasis demonstrated in the roentgenogram.

REPORT OF CASES.

Case 1 (A239524). A boy, aged 12 years, came to the Clinic in July, 1918, with aching pain and swelling in the upper third of the left humerus. The arm had been severely injured, possibly fractured, eight years before. Two months before, it had been traumatized. The arm was freely movable and without pain or tenderness; a thickening of the upper third of the humerus was apparent. The parents and the child were greatly alarmed because "sarcoma, cancer of the bone" had been diagnosed by the roentgen ray and a Berger amputation of the shoulder advised by several surgical consultants.

A diagnosis of fibrocystic disease was made in the Clinic from the clinical and roentgenographic evidence, and a conservative operation advised. The thin shell of cortex was broken through and a specimen removed which verified the diagnosis; following this the wound was thoroughly curetted and closed without drainage. Improvement in the humerus, as shown by the roentgenogram, has been observed until the normal was practically reached. The patient is alive, with good function of the arm more than four years after operation.

Case 2 (A193388). C. A. M., a boy, aged 14 years, came to the Clinic May 7, 1917, because of swelling of the lower third of the right thigh and knee.

In February he had fallen and bumped his right knee. Soreness was noted for a few days. In the latter part of March the right thigh and

knee began to swell, the enlargement slowly increasing, with only slight pain in walking. He lost weight gradually.

A hard tumor of the lower right thigh, tender on pressure, was found. Motion of the right knee was limited. The knee flexed to an angle of 120 degrees. Examination of the urine was negative. The hemoglobin was 68 per cent. The leucocytes numbered 10,400. The Wassermann reaction was negative. Roentgenograms revealed sarcoma of the lower one-third of the right femur, and the lungs were negative for metastasis. The condyles were not involved. On May 10 the right thigh was amputated at the upper third. The pathologist reported mixed-cell sarcoma. Coley's serum was advised. The patient died July 7, 1917, three months after operation, probably of pulmonary metastasis. Metastasis was undoubtedly present at the time of operation, but not discernible in the roentgenogram.

Case 3 (A365027). Mr. M. P., aged 27 years, registered at the Clinic August 9, 1921, complaining of pain in the right knee, which he had wrenched in a jump from a wagon in 1903. There was no locking nor swelling. Two operations had been performed without appreciable results. In 1919 he had contracted influenza, the knee had become very painful and swollen, and he was obliged to use crutches. He was unable to extend the leg.

The patient was found to be in good general condition. The temperature, pulse, and blood pressure were normal. The enlarged right knee was markedly tender and painful; it was held at fixation of 160 degrees. The urine contained an occasional pus cell. The hemoglobin was 70 per cent. and the leucocyte count 11,600. The Wassermann reaction on the blood was negative. Destructive arthritis of the right knee, with considerable synovial thickening, was diagnosed from the roentgenogram. On August 13 the right knee-joint was opened and a sarcoma of the periosteum of the mixed-cell type was discovered. The tumor had originated on the posterior surface of the lower part of the femur and had pushed its way through to the anterior part of the joint. The thigh was amputated, and roentgen ray, radium, and Coley's toxin were given. The patient is still under treatment 15 months later and is in excellent condition.

Case 4 (A266000). N. H., a boy aged six years, was brought to the Clinic for examination March 21, 1919. He had had pain and swelling in the right leg for 14 months. Several exploratory operations had been

performed for osteomyelitis. He was brought to the Clinic because of persistent cough which had followed an attack of influenza four weeks before, and a tumor in the calf of the right leg following operations elsewhere. The circumference of the right leg was 12 inches, that of the left seven inches. The superficial veins were prominent. The temperature was 100, the pulse 118. Primary periosteal sarcoma with metastasis to the lungs was diagnosed by the roentgenogram. The patient died within a few weeks.

CASE 5 (A247227). G. T., a boy, aged 16 years, came to the Clinic September 30, 1918, with a swelling of the lower end of the right femur and knee. Two months before, he had scratched his right knee with barbed wire; the synovitis which followed had disappeared. He then had mumps and the tumor had grown rapidly since. His home physician had aspirated the knee with negative results. Roentgenograms had been taken and malignancy suspected, and he was referred for our opinion as to type of tumor.

Examination showed sarcoma of the right femur and no evidence of metastasis of the lung. The patient was referred back to his home physician for operative treatment. The Wassermann reaction was negative. He died of recurrence and pulmonary metastasis December, 1920, following amputation.

CASE 6 (A359780). Mr. J. W. V., aged 58 years, came to the Clinic May 31, 1921, complaining of pain and swelling in the upper third of the right humerus of six months' duration. He remembered that 20 years before a similar pain followed an injury, and he was treated for neuritis. Just before the present attack he had twisted his shoulder. He came for consultation because sarcoma had been diagnosed, and a hopeless prognosis had been given.

Exploration was performed and the condition was diagnosed hemangioma. The upper half of the humerus was excised and a homogenous bone graft implanted. The patient recovered satisfactorily, returned to his work as a clerk, and is in good condition. Recent roentgenograms reveal the graft to be in good position and united. The patient still wears a protective dressing.

CASE 7 (A168792). Mrs. J. B. W., aged 53 years, was examined in the Clinic in August, 1916. She complained of nervous indigestion, insomnia,

rheumatism, and lameness of the left knee. Lameness and stiffness had been present for seven years, although there was no limitation of motion, no deformity nor tenderness. A diagnosis of sarcoma had been made elsewhere and amputation of the hip had been advised, following consultation with several eminent surgeons.

The urinalysis was negative; the hemoglobin was 80 per cent. and the leucocytes numbered 5200. The tonsils were enlarged and contained septic material. Roentgenograms showed the presence of a tumor in the lower end of the left femur which was confined to the medullary and cortical portions and was unlike any other tumor in this region I had ever seen. Other roentgen-ray findings were negative.

On August 18 the tumor was explored and found to be a chondroma. Radium was used. April 5, 1917, the tumor was curetted and the cavity filled with fat from the abdominal wall. The patient has been walking now more than six years. Thus far there is no clinical nor roentgenographic evidence of recurrence.

Case 8 (A287181). Mr. J. J., aged 29 years, came to the Clinic August 20, 1919, because of a recurring tumor of the left hand. About four years before, he had noticed swelling of the thenar eminence of the left hand. The swelling slowly reduced and interfered with flexion of the thumb. After 18 months the tumor was removed. The hand recovered full usefulness and remained normal for two years; then it again began to grow, involving the thenar eminence and outer side of the palm.

The examination revealed a hard bony tumor lying between the first and second metacarpal bones. The patient was well developed and well nourished; height five feet, eight inches; weight 154.5 pounds. The left arm was atrophied. Examination of the urine was negative. The hemoglobin was 69 per cent.; the erythrocytes 468; the leucocytes 6000. The Wassermann reaction was negative. Roentgenograms revealed the involvement of the hand and multiple metastasis to both lungs.

Case 9 (A290902). Miss G. M., aged 27 years, came to the Clinic complaining of swelling and stiffness with pain in the right knee, of about 18 months' duration. Arthritis had been diagnosed and tonsillectomy performed. The swelling had continued, but more slowly recently and with less pain. The patient had lost weight and strength.

A hard tumor, extending from the middle of the femur to below the knee, and a large hard mass in the right axilla were found. Roentgenograms of the right femur revealed mixed-cell sarcoma with destruction

of the lower half of the shaft of the femur. Metastasis was found in the base of the upper left lobe of the lung.

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AN UNUSUAL CASE OF CONGENITAL ASYMMETRY OF THE PELVIS AND OF THE LOWER EXTREMITIES.

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As regards congenital lesions, there has been much written about the tibia and the fibula, less about the femur and little about the muscular contractions not due to spastic paralysis. Therefore, it has seemed to us that the report of a case involving all these deformities would be of some interest.

H. S. is a girl 7½ years old; her parents and sisters are living and well; neither hereditary diseases nor bone deformities are present in the family. She was born at full time, weighing 7½ pounds, after a normal labor. Since then, she has had measles, mumps, chicken-pox, and occasionally tonsillitis.

She was seen for the first time, at the age of three months, in the Orthopaedic Out-Patient Department of the Children's Hospital, Boston. Since the birth, the parents had noticed some crookedness of the left leg and a contraction of the knee, both painless. At the examination the baby showed a left leg somewhat shortened, a small patella, and a limitation to extension of about 15° from the straight line. From an x-ray of the thighs, taken three months later, the left femur was estimated to be 2.5 cm. shorter and much smaller than the right. When the child began to walk there was a slight limp, which increased with the years, and some adduction was noticed later in the right foot. The treatment consisted of daily stretching of the knee and of the wearing of soles raised one-quarter inch on the outer side for the right, and a high sole for the left foot. No change in her condition was noted and in November, 1922, she was admitted to the wards.

The physical examination shows a well developed child, in good health, without any peculiarity in the head, the upper extremities, and the thorax. In the lower limbs, we find the right leg of normal size, in slight adduction, and the left somewhat shorter, with the knee flexed, and a visible atrophy between the anterior superior spine and the ankle, but principally marked in the buttock and the mesial region of the

lower third of the thigh. The skin seems of the same color, thickness, warmth on both legs, without oedema, cyanosis, ulcers, or constrictions. The gluteal fold has disappeared on the left side. The left patella is very small and easily movable. All the motions of the joints are normal in both legs, except that extreme abduction of the right thigh is prevented by some contraction of the adductors, and except, also, total extension of the left knee, which remains flexed to about 25°, because of the contraction of the inner hamstrings, combined with the lessened power of the quadriceps. The back shows a slight total left dorsal curve. The patient walks with the pelvis tilted downward towards the left side, with the left knee slightly flexed. There is double genu valgum, adduction of both legs and a left equinus.

The measurements are as follows:

Right.		*Left.*
56.4 cm.	...Length between ant. sup. il. spine and int. malleolus...	49.2 cm.
27.6 cm.	......................Length of femur.....................	24 cm.
2.1 cm. by 2.1 cm.	................Patella................	3.6 cm. by 2.7 cm.
24 cm.	......................Length of tibia.....................	23.4 cm.
12 cm.	...Length between external malleolus and tip of big toe...	12 cm.
10.8 cm.	....Distance between umbilicus and ant. sup. il. spine....	12 cm.
34.8 cm.	.................Circumference of thigh.................	33.6 cm.
25.8 cm.	..................Circumference of knee..................	25.2 cm.
21.6 cm.	..................Circumference of calf..................	19.2 cm.
15.6 cm.	.......Circumference of the leg above the ankle........	15 cm.

The muscle examination reveals on the left side a poor quadriceps, a fair outer hamstring, a normal or very slightly contracted calf group and normal toe flexors. All the other muscles have good power. On the right side, all the muscles are normal, except that the right lateral abdominal is a little weak. The muscle balance test of the left quadriceps registers a power of eight pounds (normally 30 pounds, at 7 years). All the others show practically normal power.

The x-ray picture shows: no bone changes in the upper extremities; a normal spine with a slight left dorsal scoliosis; an asymmetrical pelvis, with a left iliac bone reduced 6 mm. in height and a left pubic bone somewhat narrower than the right; the left iliac crest 2.7 cm. below the level of the right; the left femur with an angle more obtuse, 155° instead of 150°, and some atrophy of the shaft, which is reduced 6 mm. in width, while the cortex is 3 mm. narrower than the right. The left tibia is 3 mm. narrower than the right, with some atrophy also; the left fibula medially rotated, without narrowing; there is no bone destruction, but a marked decreased density throughout these bones.

H. S. Lateral view. November, 1922.

H. S. Posterior view. November, 1922.

The reflexes are normal except the left knee-jerk, which is absent. No Babinski, ankle clonus, Gordon, or Kernig, can be elicited. The superficial and deep sensibility is normal. The Von Pirquet and the Wassermann reactions are negative.

The intelligence is that of a child of her age.

This picture is common in cases of early infantile paralysis, but there is no history of such a disease and the symptoms were noticed at the birth.

Treatment: A plaster-of-Paris cylinder was applied to the leg from the ankle to the groin, with the knee maximally extended. Some hours thereafter, at the level of the popliteal space, a transverse split was made and by successive throat-sticks inserted in this split, the extension became quite complete after three weeks, so as to increase the length of the leg to about 3 cm. A caliper splint was then applied, which will maintain this correction. A shoe was fitted with a high sole to compensate for the shortness of the limb.

The few cases reported which have a direct relation to the affection of our patient, are the following:

H. S. X-ray, left knee.

Vines Ellis has described a specimen, now in the Museum of University College of London, with a pelvis without acetabulum, articulated at the anterior superior iliac spine with irregular pieces of bone. The right femur is absent, the left one is rudimentary. The right tibia is forked and shortened; the left tibia and fibula are of the usual size and the knee-joint is complete.

Rundle has made a study of a boy ten years old with short legs, whose fingers touched the ground in the erect position. His right leg, 9½ inches long, showed a talipes equinus, while his left one, 14½ inches long, was in an adducted position out of line of the center of gravity of the body, with the foot in calcaneo valgus. The 5¼ inches difference in length was compensated for by an oblique pelvis tilted downward to the right side and a lateral spinal curvature. An autopsy made at 30 years of age established the fact that the asymmetric pelvis was more

H. S. X-ray, right knee.

developed on the left side, and that there was a lack of acetabulum on both sides, a short femur, a diminished fibula, and a short, enlarged tibia with an almost normal foot on the right side, while the left tibia and fibula were of full length and the femur absent.

Joachimsthal reports the case of a woman of 22 years with a congenital deformity of the right leg and the right half of the pelvis. On this side, only the ischium is of normal dimensions, but twisted with the tuberosity pointing upward; the skeleton of the lower extremity is formed of two small bones, one medial and anterior, resulting from the fusion of the femur and the tibia, the other, lateral and posterior, being the fibula.

Scarlini describes a boy of 9 years, whose left half of the body and upper right extremity are quite normal, but who is affected with a rudimentary right leg coming about to the level of the left knee, and showing a permanent flexion at the hip and at the knee, while his right foot

Ill. 8. X-ray of pelvic and femoral bones.

has lost its normal size and forms a rudimentary irregular appendix. According to the x-ray there is a marked hypotrophy of the sacrum; the right half of the pelvis is composed of an ischium, forming the inferior part of the acetabulum situated at the level of the third sacral vertebra. The femur is extraordinarily small, without a trochanter, with 11 cm. shortening and a diameter of only half that of the normal femur. In the leg there is only one bone, the tibia, with 2 cm. shortening and a diminished density. The bones of the foot are abnormal. There is no

astragalus, and the calcaneus, arrested in its development and modified in its shape, is articulated with a series of little bones impossible to classify.

De Castro cites a case in which the left femur was represented only by its distal epiphysis and the iliac bone smaller on the same side, all of the rest of the skeleton being normal.

Etiology: As to the etiology, two theories have attempted to explain these congenital abnormalities. The first is based upon exterior causes like pressure of the limb in a defective position by narrowness of the uterus or lack of sufficient amniotic fluid or fixation by the umbilical cord or by amniotic bands. But this opinion has fewer and fewer defenders in the cases where no external skin constrictions have been discovered at the birth. For the second, intrinsic factors are held responsible. Abnormal osteogenesis is inferred, explaining in the same way rudimentary or lacking bone formation and supplementary or heterotypic bones by the disturbance of the functions of the osteogenetic centers or the production of abnormal osteogenetic centers. Thus the entire limb may be modified in very different ways.

Now, what is the determining cause? *Dareste* thinks it is an arrest of development of the amnios with compression of the leg, producing bone atrophy and lessened blood circulation. Other authors like *Klippel* and *Rabaud* are of the opinion that it is due to a lack of general nutrition, causing local disturbances. The experiments of *Poynter* seem to afford some support to this assertion. In a series of chick embryos in which development was disturbed in order to study the process of dissociation, lateral asymmetry frequently occurred. Eighty per cent. of those in which circulation was partially destroyed or its development prevented showed lateral asymmetrical development or degeneration, and the entire lateral half of the body may share in the delayed development. This is also corroborated by the results of *Loeffler's* work on congenital contractures, showing that ischemia of the muscles plays an important rôle in their contractures.

To sum up: Probably the origin of the affection of this child is the result of a disturbance of the circulation at an early period of intra-uterine life at the time of formation of the left femur, tibia, and fibula, but having stopped or been compensated for by lateral anastomosis when the foot was developed.

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PHYSIOTHERAPY IN BACK SPRAINS.

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The incompleteness of pathological diagnosis, the disregard or only empirical use of physical therapy, and the orthodox treatment with prolonged rest and immobilization cause individuals who have sustained back injuries to suffer such long periods of disability.[1]

Treatment with mechanical and physical remedies can be efficient only if the therapist understands the underlying pathology and is well acquainted with actions and modes of application of the measures which are at his disposal.

Concerning the pathological anatomy of back sprains, great difficulties are encountered in view of the limited clinical data to determine the damage to fibrous, muscular, and ligamentous structures. The radiograph reveals only bone changes, such as fractures, neoplasms, bone atrophy or hypertrophy, while it discloses nothing about the condition of the soft tissues of the back involved in sprains, contusion of muscles, or tear of ligaments. The x-ray findings aid, however, by contributing to our knowledge what factors preëxisted or accompanied the injury to influence the spinal muscles and ligaments. The damage to the latter is determined by the history, the patient's complaints, and the physical findings. It is essential to obtain a complete history, with special attention to occupation and customary posture at work, with a full understanding of the manner of force and the mechanism of production of the injury. The complaints—pain, tenderness, stiffness, and weakness in the back—must coincide with the facts of the history and correspond in location and severity with the data obtained relative to the injury. The clinical findings must be regarded as logical sequels of the above factors: history and complaints.

Clinically important are the peculiarity of spinal deviation; the comparative size of the erector spinae and adjunct spinal muscles, *i.e.*, atrophy or hypertrophy; the distribution of tenderness and spasm, which are most valuable aids in locating the lesion, and, finally, any previously existing cause of backache of local, remote, or constitutional origin.

To exclude possible malingering, so apt to occur in compensation patients who have sustained back injuries, attention must be paid to the

general attitude of the patient towards the examiner: his answering questions, his aptitude to exaggerate facts and complaints, and his resentment to minimizing the seriousness of his accident and suffering.

With the above data at hand, excluding spinal fractures and backaches of other than traumatic origin, we may attempt to draw a pathological picture and establish a diagnosis of sprained or contused back, acute or chronic, the physiotherapy of which the writer desires to present.

ACUTE BACK INJURIES.

The object of physiotherapy here is the removal of inflammatory products in the traumatized tissues. As these cases never present themselves for operation or post mortem examination, the exact pathology can be deduced only from our knowledge of traumatic inflammation consequent to muscle and fibrous tissue rupture and ligamentous tear, *viz.*, petechial bleeding, round cell infiltration, and serofibrinous exudation. Only after excessive trauma may there be found additional injury to the nerve supply and temporary or permanent paralysis of the muscles.

To disperse this inflammatory exudate and to prevent the establishment of stasis one of the mechanical electric modalities must be locally applied. The term mechanical is used advisedly because such is their action, since they cause contraction of the tissues required to force out, by way of the lymphatics, the accumulated fluid, including the round cells and other degenerative waste. Of such modalities there are at our disposal the induction, the sinusoidal currents, and the high frequency or static sparks. Either of these can be chosen or be used alternately on successive days of treatment, as is the custom of the writer.

Preceding this application, the back is exposed to radiant light and heat from a high candle power incandescent lamp or from a hood lined with numerous light globes. This penetrating heat is effective in relieving muscular spasm and pain by enlarging the channels of circulation through the dilatation of the capillaries.

Following the electrical treatment, manual massage and light mechanical vibration are applied to further disperse the effusion and to promote normal blood supply, to hasten repair, and to prevent adhesions. Of the massage procedures only two are applicable here: petrissage and effleurage in the direction of the lymphatic flow. For the erector spinae muscle group draining into the cervical and the inguinal glands, the stroking must be directed upward and downward, instead of in one direction only, as in all other muscles of the body.

Massage is succeeded by resistive exercises, selected according to indications for each individual case, to overcome the muscle spasm. These movements are executed in a direction opposite to the contracted muscles, *i.e.*, the antagonists to the spastic muscles are made to work to overcome the spasticity. When the spasm is abolished, corrective movements to increase muscle strength are added.

In massage and in exercises the operator must guard against fatigue of the muscles lest spasm increase and the treatment defeat itself. To be efficient, both must be executed most gently and within the limit of pain.

While thus treating the patient every day, the back is protected by means of adhesive strapping, by a pelvic belt with back extension, a spinal brace, or a removable plaster of Paris jacket. For most cases adhesive strapping will suffice, since the patient may be restored to usefulness within about one week; in more extensive injuries a permanent removable support is needed to protect the spine, especially for the night when unconscious moving about may harm the healing tissues. The average acute back sprain will be restored to normalcy in two to three weeks.

There are acute cases which do not respond readily to this form of treatment, but require additional spinal manipulation, as practised so extensively, and at times successfully by adherents to drugless cults. The pathology of such cases, though not definitely established, is undoubtedly a mild displacement or subluxation of joints as discussed by Fassett,[2] Davis,[3] Marshall,[4] and other medical writers, and as experienced by myself by relieving pain and back fixation through a sudden "thrust" given to the spine in the hyperextended position. The patient may be awake, or under a general anesthetic if the cramped position cannot otherwise be overcome.

Following forcible manipulation, I proceed with physiotherapy and back protection, as outlined above.

CHRONIC BACK SPRAINS.

Physical therapy should not be instituted unless it has been established definitely that we are dealing with an organic condition, and not with an hysteric or compensation-neurotic individual. The neurotic is best helped by a permanent disability rating; the hysteric by neurologic treatment without or with physiotherapy, as described by the writer in a previous article.[5]

Chronic cases are the outcome of prolonged rest and immobilization in a plaster jacket or brace with inefficient or no physiotherapy at all in the acute stage. Instead of removing pathological products and diminishing the accumulated debris, they have been allowed to persist, to organize fibrous tissue to be deposited within the muscles and muscle sheath—thus a fibrosis to become established. The organization of effusion may even lead to scar formation which may eventually contract and result in a persistent spinal deviation, or the organized fibrous tissue may undergo degeneration and, in rare instances, ossification.

With this pathology at hand our aim should be to convert the inadequate state into an adequate reaction by means of physical modalities which will soften the organized scar tissue, make it more pliable, and create within the fibrosed muscles an artificial hyperaemia and effusion, to be dispersed later by mechanical means.

The softening effect is attained by the aid of stimulating agents which will produce local hyperaemia. Beginning with radiant light exposure from high candle power incandescent lamps to cause superficial heating, the treatment is followed by the passage through the deeper tissues of the high frequency electric current which produces heat within them, the so-called diathermic current. Surface and deep heating are preparatory to electric modalities which are to succeed, such as negative galvanic ionization with chlorine or iodine ions to augment the softening of organized tissues, and the static or faradic currents to disperse the inflammatory products thus created from the muscles and ligaments. The sitting is concluded by vibration and massage to dissipate to the utmost the exudate from the superficial and deep layers.

With the massage are combined exercises, passive and resistive, to stretch the contracted tissues, to increase spinal motion, and to gain muscular power. Overuse, fatigue, and pain elicitation must be guarded against at all times, just as in the acute stage.

The spine is not immobilized in an irremovable jacket, but after each treatment which is given daily, unless contraindicated by pain and increase of spasm, a spinal spring brace or a canvas belt with a spring back extension is applied to partially inhibit motion. The brace is worn at night, while in the daytime it is removed during treatment and when the patient exercises: exercise being encouraged and performed within the limit of pain.

The time required to restore the spine to a functioning condition is about 6 to 10 weeks, during which period the support is worn and then gradually discarded.

The treatment outlined for chronic sprains should be applied to healed fracture cases as well. After the fractured spine has been immobilized for about six months, as customary, it should be dealt with therapeutically, like a chronic sprain of muscular, ligamentous, or fibrous tissues. The only difference to be observed is the limitation of exercise, because of the uncertainty of perfect and strong callus. The disregard of physiotherapy and the protracted immobilization are the reason of the long lasting disabilities, two years or more, for spinal fractures.

SUMMARY.

To obtain a pathological picture and derive the diagnosis of back sprain, a complete history of the patient, the manner of production of the trauma, and the clinical, laboratory, and radiographic findings must be secured in order to exclude cord and bone lesions, and backaches of remote and constitutional origin.

Having established the diagnosis of back sprain by excluding other possibilities, local physiotherapy should be instituted with only partial restriction of back motion. This will reduce the time of disability to a minimum and prevent the formation of chronic back sprains. If such have developed or have resulted from the necessary immobilization of spinal fractures and acute spinal arthritides, they should be submitted to a thorough treatment with physical modalities, instead of remaining mobilized for a longer period of time.

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REPORT OF A CASE OF MYOSITIS OSSIFICANS PROGRESSIVA WITH BIBLIOGRAPHY

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R. K. Ten years of age, one of twins. Normal birth. No instruments. Has had whooping-cough and scarlet fever; no other illnesses. Had fall from high chair when one year of age, and 6 months later present condition started in his neck. In the words of the mother, "It was poulticed, and it went all over his body." He did not become much worse until five years of age; since then it has been slowly progressing. He has three brothers and two sisters, living and well. One sister died of the whooping-cough at the age of two years. There is no history of a similar condition in any branch of the family.

Present examination shows well appearing boy of apparently normal height and weight, holding his head in position of wry neck. It is distinctly noticeable that there is no movement of the head.

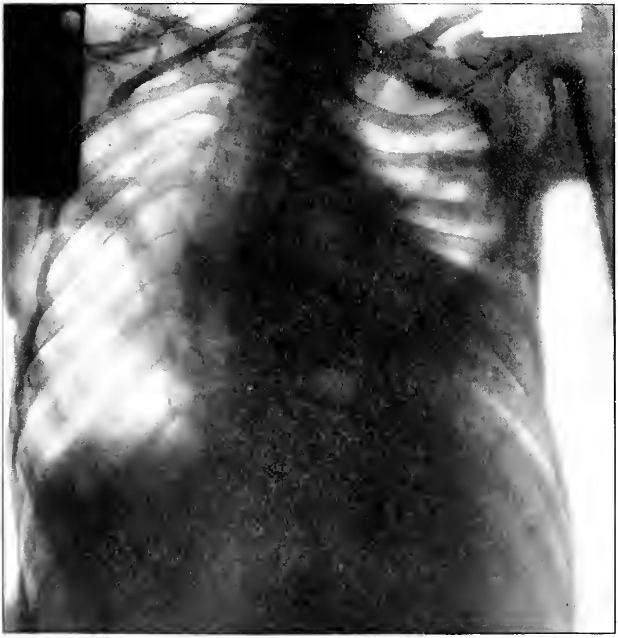
Examination discloses the following muscles as being involved: the masseters, fixing the inferior mandibular articulation so that only one-half an inch separation of the incisors can be obtained, none of the muscles of expression; both sterno-mastoids, trapezius, and probably complexors, the latissimus dorsi, the external oblique abdominalis of the right side, both pectoral muscles, the major on each side changed to almost solid plates of bone, the subscapularis and teres major, the biceps and coracobrachialis and triceps. There are but three or four degrees of motion at the elbows, movement at the wrist fair, right arm fixed in pronation. A remarkable ridge of ossification extends downward and backward in a serpentine manner from the left nipple for three and a half inches. It is raised from the surrounding surface one-half inch, with a base one-quarter of an inch wide. The skin is non-adherent except in one spot, and here it is probably due to pressure with slight inflammation. The adductors of the right leg are ossified throughout their length. A plate of ossification extends down the fascia lata. The ossification is less marked below the knees, although the knees themselves are markedly involved. No ossification found in the skin after a thorough search. No microdactylia present. Wassermann negative. Blood analysis showed decrease of calcium content. Five c.c. of the blood removed for examination was injected into the quadriceps of the left leg. The same quantity of sterile salt solution injected in the other quadriceps in similar

[Radiographs taken by Dr. Charles W. Fairchild.]

position and manner. X-rays taken two weeks later failed to show any changes at the sites of injection.

Myositis ossificans progressiva is a disease of early life in which the fibrous tissue in and about the muscles changes to bone. It steadily progresses, and may eventually render the subject a veritable ossified man. No therapeutic measure is known to retard its progress. It is

usually accompanied by defects in the development of the toes or fingers (microdactylia). It differs from myositis ossificans circumscripta and



myositis ossificans traumatica in that trauma in the light of external violence does not seem to be an etiologic factor. Myositis ossificans traumatica has a satisfying etiological factor in the torn and displaced periosteum. But the periosteum can be absolutely ruled out as a causative influence in this disease.

Most exhaustive studies of the metabolism, in which the intake and output were analyzed, failed to show anything abnormal. The excretion of calcium is unaffected. Austin states that the patient whose calcium metabolism he studied "seems to offer a perfectly normal metabolism,

which consists in a calcium equilibrium on a mixed diet of sufficient amount; a loss on an insufficient amount of a mixed diet, and a loss on an ample diet of foods poor in calcium.'' As grapes, oranges, and bread appeared in this diet, a lack of carbohydrates could have had nothing to do with the loss of lime in the body. Goldthwait, Painter, Osgood, and

McCrudden, in a very carefully conducted series of investigations, demonstrated a constant loss of lime in osteomalacia. Absolute loss of lime has been demonstrated in pernicious anemia. When loss occurs in phthisis, it is due to inanition and not to the disease. The calcium loss which invariably follows insufficient nourishment can be accounted for only by the assumption that the bones are broken down to a certain extent, thus setting their calcium free. This assumption has been substantiated in dogs (Forster) and in human beings (Munk).

Microscopic study of the newly formed and forming bone shows nothing which differs from new bone formation following trauma. There is present haemorrhage, connective tissue hyperplasia about the clot,

calcification, and ossification. The haemorrhage may mechanically start the cell changes by pressure,—may provide the calcium which is necessary or may do both. Both of these factors exist probably frequently in everyone, and yet this excessive bone formation is a rare condition. Since the microdactylia is present in the majority of cases, it would seem justifiable to look for congenital malformation in other body cells. Thus we

may account for abnormal capillary walls, easily permitting extravasation of blood, and likewise abnormal connective tissue cells, permitting the ready production of necrosis, calcification, and ossification.

Rolleston classified this as a developmental disease of the mesoblast, but Rosenstein found bone formation in the skin of his case, which must change the charge against this embryonic layer, and Rosenstein surmises "that the pathogenetic cause exerts its influence at a very early period of embryonic life, before any distinct differentiation (of embryological layers) has begun."

Delayed coagulability might be thought a factor, but instead it is ahead of normal time. That the pressure necrosis following the haemorrhage is at least an incentive to the bone formation would seem to be logical, inasmuch as calcification and ossification of necrotic tissue has been repeatedly observed in various organs.

Rosenstein compiled 120 cases in chronological order. The first was one reported by Guy Patin, in 1692, and his last was his own, which he reports in detail. Of these, however, he finds five were not true cases, and his list covers, therefore, 115 cases. This report adds fourteen new cases from the literature and my own case, which brings the total number of cases reported to 130. Our bibliography contains only verified

references. Of these 130, the sex was not stated in 8, and of the 122 remaining, 74 were males and 48 were females.

The age at which the first symptom was noticed is not given in 18 cases. In the rest it was two or under in 39 and under 10 years in 102. In only a very few cases is it noted as being present in relatives.

Case 1—Reported by Almond, G. H. H. Adenoids removed at 3½ years. Glands in left neck removed one year later. At 5½, swelling of ankle, which rapidly subsided. After this, stiffening of the hips, knees; ossification of the biceps of arms; of iliotibial band, hamstrings, etc. Ossification occurs in fibrous and connective tissues as well as in muscles. Great toes normal. In discussion, septic infection as etiology for this case was suggested.

Case 2. Reported by Andersen, K. Girl, 8, of healthy parentage, born with deformity of both thumbs and big toes. Swellings appeared in front of both ears and progressive trismus developed, with difficulty in swallowing. At the same time hard nodules formed in the masseter muscles on both sides. The swelling gradually subsided, but seemed to move on to the shoulders, where hard nodules now formed in the muscles. One of the swellings threatened to rupture through the skin, and was removed and found to consist of bone tissue. The stiffness and swelling showed alternate improvement and aggravation. General condition good, but there was well marked trismus so that the upper and lower teeth could not be separated; there was a small open-

ing just large enough for food to be introduced. Several hard bony nodules could be felt in masseter muscles, especially on the right. Shoulders greatly involved; both upper arms held in abduction; very slight flexion. On right side, bony masses in latissimus dorsi and the pectoralis major was indurated as a whole; on left, several isolated hard bony nodules were palpable. Other muscles in upper extremities normal.

Same case as Andersen's. Reported by Hoyer, S. Hoyer had previously rendered diagnosis unknown to Andersen. Hoyer extirpated the nodule, which was examined microscopically (there was no danger of skin rupture; extirpation was done simply for examination). Specimen was removed from one of the hardish and largest indurations from border of right latissimus dorsi and scapular angle. Microscopic diagnosis was fibromatosis, no ossification being demonstrated. Designation as "myositis" is incorrect; the Japanese investigator, Goto, accordingly calls the disease "Hyperplasia fascialis progressiva."

Case 3. Reported by Caronia, G. Girl, 4 years. Series of protuberances at nape of neck and in lumbar region. Active and passive movements greatly limited in neck, trunk and upper limbs. Slight microdactylia of thumbs and big toes; shortening of phalanges of little fingers.

During observation, protuberances became more pronounced, and others were found in the tendinous insertions of the biceps muscles of arms.

Various therapeutic measures—mercury, arsenic, antimony, iodine, thyrodine, adrenalin, thymic extract, hypophysin—proved inefficient.

Case 4. Reported by Drago, A. Girl 8 years. Trouble began at about 4 years, after slight traumatism of right axillary region. A swelling appeared, then disappeared; the same occurrence took place then in other localities. Two months after onset pain in hip and dragging of foot followed. Radiography showed pectoral muscles sclerotic and retracted. Shadows corresponded to nodules of bony and cartilaginous character palpable in the muscular mass.

Shoulders seemed ankylosed, though the joints were intact. Microdactylia of big toes and thumbs.

Case 5. Reported by Eiselsberg, A. Smallpox at 4, followed by stiffening in right elbow; at 14 years hardening had taken place; in 18th year a tumor below the shoulder-blade. Constant annoyance from hardening of right semimembranous musculature.

Case 6. Reported by Grant, J. W. G. Girl of 4 years. Large irregular plates of bone in various tendons of erector spinae muscles and in the latissimus dorsi, pectoralis major, and teres major.

Peculiar deformity of thumbs and great toes, caused by absence of proximal phalanges.

Seventy-five per cent. of the recorded cases have shown such deformity, and it is quite probable that in the remaining 25 per cent. the condition escaped notice.

Although Grant operated with some success as regards position of the arms, he does not think the operation worth doing, as recurrence has followed in every recorded case.

Case 7. Reported by Hill, M. C. Patient, boy of 12, presented. After 9 months of age, he had measles, whooping cough, and mumps, and at 2½, swelling of right side of neck, which has persisted and become progressively harder. Following this, muscles of back began to show areas of ossification, and also those of arms and legs. At present, boy presents many deformities—striking example.

Case 8. Reported by Horand, R. Man, 36 years. Family history negative. Mother "delicate." Disease began in early youth, at 7. Patient had attacks of blood spitting—hemoptysis. The man stated that the trouble began at the top of his head, and followed the spine to the lower portion of the back, paralyzing both arms to the shoulders, the neck, and jaw. After a kick, the left leg was paralyzed, and after a fall, the right arm, which had been immobilized for 5 years, was broken. Then the other leg and other arm were in turn mobilized.

Patient is intelligent; bad general condition; much eczema; terribly thin; body covered with protuberances; shoulders stick out and are carried in advance.

"Une statue vivante qui a la notion d'equilibre." He is carried about like a block.

The masseter muscles are as yet not involved, but the patient can hardly use his teeth, since the inferior maxilla is fixed to the left sterno-cleido mastoid. There is a bony prominence between the cranial base and the vertebral column at the level of the spinal apophyses. The head cannot be turned; the sterno-cleido mastoid muscles are totally involved at the left. Both trapezius muscles are involved. Intercostal, pectoral, dorsal muscles involved. Arms and legs almost useless.

Visceral organs and organs of sensibility, blood system, and nervous system all appear normal.

Thyroids and parathyroids appear atrophied, a significant fact in relation to calcium metabolism.

Even in a few months' observation the general condition has become worse. The patient is becoming more and more petrified. His "carapace" continually crystallizing threatens to envelop him in a strong shroud.

Case 9. Reported by Kohlhaas. Man, 44 years. Up to 12th year, patient had been well; he then began to suffer repeatedly, without a known cause, from attacks of pain and swelling in muscle groups. Examination showed that a large portion of the muscles of the neck, back, shoulders, upper arms, and thighs were involved. The jaws could not be opened; the neck was held rigid; the arms could not be moved in the shoulder-joints; elbow and knee-joints were likewise affected. The x-ray plates showed abundant evidence of ossification.

This man, a Roumanian, was presented by Virchow and others in the nineties, and later on utilized his deformity for commercial purposes. His case was written up by Virchow in 1894. See Rosenstein, p. 15, case xlvii.

Case 10. Reported by Manuwald, A. Typical case. Girl 4 years. No faulty heredity. Microdactylia of thumbs and big toes. The author suggests Stempel's theory of imperfect differentiation of mesenchyma; the original germinal tissue under these pathological conditions retains the capacity of continued bone formation. This case presented the appearance of cervical spondylitis, but the vertebral column was intact. The sterno-cleido mastoid muscles were implicated; the muscles at the nape of the neck were diffusely swollen and board-like to the touch. The head was nearly fixed. The large pectoral muscles contained bony deposits.

Case 11. Reported by Paterson, A. M. Showing of skeleton of recent case of myositis ossificans (progressiva?).

Almost complete ankylosis of vertebral column; atlas and coccyx alone being free. Ankylosis of lower jaw and extensive formation of new bone from left mandible, resulting after operation intended for relief of condition.

Many joints show arthritis; limb bones characterized by exaggeration of muscle attachments and irregular exostoses.

Case 12. Reported by Stewart, W. H. Boy, 8 years. At $3\frac{1}{2}$, whooping

cough and measles. After this, mass in neck, progressively becoming larger. Within week, limitation of motion; lumps in back; great weakness. Marked ossification of all muscles of back; ossifications present transverse ridges on either side. All shoulder muscles, biceps left arm, quadriceps left thigh, abdominal muscles, muscles of mastication and expression, and "those of the right" involved.

Stereo-roentgenographic examination reveals ossified ridges across back, involving all muscles.

Case 13. Reported by Thomas, B. A.; Harrison, F. G. Girl, 4 years. Congenital malformation great toe. Measles; whooping cough. A fall, after which bump developed in back; later, child had chicken-pox. Lump in back grew larger and others appeared; limitation of motion of the spine, shoulders, and hips. Evening rise of temperature; no cough; Wassermann negative. Mother tuberculous.

Case 14. Reported by Thompson, T. Man 43 years. At 8 years, shoulder became swollen and painful. At 16, pain and swelling at bottom of back. At 28, left leg and thigh became stiff. Arm later affected. Most of the muscles are infiltrated with hard, bony growths, so that his back is perfectly rigid. Masseters infiltrated with bone, and jaw is fixed. Deformity both great toes.

Pathological report (Turnbull) on portion of muscle (right pectoralis major) near calcareous area and a portion of tendon and hard, white bony substance.

This patient was one of the subjects in an investigation (Spriggs, unpublished) of metabolism of creatinin and uric acid in "some diseases of the muscles." The disturbance in creatinin excretion was not great.

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News Notes

The Shriners' Hospital Unit, which started its work for the relief of crippled children in Honolulu the first of this present year, examined, for diagnosis and classification, during the month of January, ninety-six cases, of which twelve were refused admission to the Hospital on account of mental deficiency.

The remaining 84 were classified as follows:

Infantile paralysis, 37; tuberculosis, spine, 4; tuberculosis, hips, 8; spastic paresis, 11; club foot, 7; obstetrical paralysis, 3; rachitic bow legs, 2; congenital flat foot, 2; congenital hip, 2; polydactylism, 1; torticollis, 1; contracted hand (traumatic), 1; osteomyelitis, 1; ankylosis, elbow, 1; unclassified, 3. Thirty patients were admitted to the wards.

Dr. Hatt, who is in charge of the Unit, says that there are fifty crippled children now on the waiting list for admission to the Clinic, and that the early estimate of one hundred fifty crippled children on the islands has now been revised to four hundred.

A new thirty-bed ward and an operating room are under construction, and the people of the Island are offering splendid coöperation in the work.

On February 2, 1923, a number of orthopaedic surgeons of Chicago met at the University Club of Chicago and formed an organization, taking the name of the Chicago Orthopaedic Club.

Dr. John Ridlon was elected President, Dr. Edwin W. Ryerson, Vice President, and Dr. H. B. Thomas, Secretary and Treasurer.

The following men were present: Dr. John Ridlon, Dr. H. B. Thomas, Dr. Charles M. Jacobs, Dr. Philip Lewin, Dr. C. A. Jacobson, Dr. S. C. Woldenberg, Dr. J. P. Sprague, Dr. Frank G. Murphy, Dr. M. Bernstein, Dr. T. J. Sullivan, Dr. J. Myers, Dr. E. W. Ryerson, Dr. E. J. Berkheiser, Dr. F. C. Test, Dr. B. H. Moore, Dr. G. H. Musselman, Dr. R. O. Ritter, Dr. D. F. Clark, Dr. E. B. Fowler.

The winter meeting of the Interurban Orthopaedic Club was held in Montreal on January 19 and 20, 1923.

On the first day the following programme was presented at the Children's Memorial Hospital:

1. A Discussion on the Calcification of Tuberculous Lesions in Children with an Illustrative Case. To be opened by Drs. Lawrence J. Rhea and Mackenzie Forbes.

2. A Discussion on Poliomyelitis. (a) Pathological Lesion, to be opened by Dr. Lawrence J. Rhea. (b) Early Diagnosis and Treatment, to be opened by Dr. H. B. Cushing.

3. Lantern Slide Demonstration of (a) Melanotic Sarcoma of the Eye with Metastases; (b) Congenital Tumor of the Kidney; (c) Congenital Tumor of

the Ovary in a Child Seven Months Old with Precocious Sexual Development. Operation and Recovery. To be presented by Dr. Lawrence J. Rhea. Discussion to be opened by Colonel Kenneth Cameron, Drs. H. B Cushing, R. Kerry, Lionel M. Lindsay and H. Rupert Derome.

4. A Case of Dystonia Lenticularis. To be presented by Dr. H. B. Cushing. Discussion to be opened by Dr. A. A. Robertson.

5. A Discussion of the Rheumatoid Conditions. (a) Pathology, Dr. Lawrence J. Rhea; (b) Etiology, Classification, etc., Dr. H. B. Cushing; (c) Biochemistry, Dr. I. M. Rabinovitch; (d) Treatment, Dr. Mackenzie Forbes.

6. The Life History of a Child, Illustrating the Development of Rickets. To be presented by Dr. H. B. Cushing. Discussion to be opened by Dr. Alton Goldbloom.

7. A Discussion of the Physiological Principles Involved in the Transplantation of Muscle. (a) Presentation of Two Cases, Dr. Mackenzie Forbes; (b) Neuro-Physiological Aspect, Dr. A. A. Robertson.

8. A Discussion of the Various Stages of Pyogenic Osteo-myelitis. To be opened by a Discussion of the Clinical Features and a Lantern Slide Demonstration of the Concurrent Changes in the Bone, Dr. Mackenzie Forbes.

9. Congenital Abnormalities of the Bones. A Series of Cases to be presented by Dr. F. P. Yorston.

10. Open Air Treatment of Diseases. Inspection of a New Self-contained Hut.

The meeting of the second day took place at the Royal Victoria Hospital, where the programme was as follows:

Tuberculosis of the Knee-joint, Dr. W. J. Patterson.

Gall Bladder Drainage—Interpretation of Results, Dr. R. H. M. Hardisty.

(a) Intertrochanteric Fracture of Femur. (b) Hip Cases. Dr. W. G. Turner.

Pathological Conference, Professor Oertel.

Unusual X-Ray Cases, Dr. Pirie.

Delbet Method of Treating Fractures of the Tibia and Fibula, Dr. Alex. Fraser.

(a) An Unusual Fracture, "Marble Bone." (b) Hospital Records, Dr. C. B. Keenan.

The Section in Orthopaedic Surgery of the New York Academy of Medicine met on Friday evening, Dec. 15, 1922. The following cases were reported:

(a) Open Reduction for Congenital Dislocation of the Hip, Herbert A. Durham, M.D.

(b) A Case of Rachitic Scoliosis; X-Rays.

(c) Scoliosis Due to Empyema. X-Rays. Nathaniel Mills, M.D. (By invitation).

(d) Two cases of Sprengel's Deformity, Treated by Operation. Herbert Taylor, M.D.

PAPERS.

(1) Pathological and Clinical Studies and Observations following Operations for Spine Fusion. Alan De Forest Smith, M.D. (By invitation.)

(2) Lumbo-Sacral Region; an Anatomical Study, and some Clinical Observations. Herman L. Von Lackum, M.D. (By invitation.)

On Friday evening, January 19, 1923, the programme was as follows:

PRESENTATION OF CASES. (From the Hospital for Ruptured and Crippled.)

(a) Result obtained in the treatment of epiphyseal separation, neck of both femora. Lantern Slides.

(b) The result of transplantation of tibialis anticus for paralysis of peroneal tendons.

(c) Unusual fracture of the shaft of the femur in a child. Lantern Slides. Charlton Wallace.

(d) Report of a case of recurring tuberculous abscess, rupturing into the bladder. Brainerd H. Whitbeck.

(e) Periosteal chondro-sarcoma of the tibia.

(f) Unusual injury of the patella. Samuel Kleinberg.

(g) Case of subcapital fracture of neck of the femur. Armitage Whitman.

(h) Tendon transplantation for irreparable injury to the posterior interosseous nerve.

(i) Secondary Os Calcis. Arthur Krida (by invitation).

(j) Healed fracture of the spine. Irving Balensweig (by invitation).

(k) Fracture-dislocation of the wrist. Neil G. Rosén (by invitation).

(l) Result of operation for ruptured quadriceps extensor.

(m) Unusual fracture of elbow. Isidore Zadek.

(n) A new method for reducing congenital dislocation of the hip—demonstration of a new instrument.

(o) A new bed traction apparatus; lantern slides. Percy W. Roberts.

PAPERS OF THE EVENING.

(a) "The Relation of Congenital Syphilis to Lesions of Bones and Joints." Percy W. Roberts.

(b) "Arthroplasty of the Knee." Illustrated by lantern slides. Willis C. Campbell of Memphis, Tenn. (by invitation).

The Section also held a meeting on Friday evening, February 16, 1923, with the following programme:

PRESENTATION OF CASES AND CASE REPORTS.

(From Mount Sinai and Montefiore Hospitals.)

(a) Report of three cases of spondyloarthritis of the atlas (x-ray demonstration) (1) due to actinomycosis; (2) dysenteric; (3) of unknown etiology.

(b) End-results in congenital dislocation of the hip.

(c) End-results in fracture of the neck of the femur.

(d) End-results in delayed union following fracture of the tibia. P. William Nathan.

(e) Aplasia.

(f) Metaplastic osteitis, with multiple fractures. Edgar D. Oppenheimer.

(g) Pathological fracture of the humerus. Sigmund Epstein.

PAPER OF THE EVENING.

"Loose Bodies in the Joints and Bursae Due to Synovial Osteochondromatosis." Melvin S. Henderson, Mayo Clinic, Rochester, Minn. (by invitation).

The twenty-fifth anniversary of the Netherlands Orthopaedic Association will be held at Amsterdam on May 25th and 26th, under the presidency of Dr. Murk Jansen. The occasion will be a noteworthy one, and many celebrated orthopaedic surgeons will contribute to the success of the meeting. Among the invited guests are Professor Putti of Bologna, Professor Spitzy of Vienna, Professor Biesalski of Berlin, Dr. Calot of Berck Plage, Sir Robert Jones of Liverpool, and Dr. Brackett of Boston.

It is with much regret that we announce the death of Dr. L. Bruce Robertson, of Toronto, which occurred on February 24th, following a brief illness with pneumonia.

The Thirty-seventh Annual Meeting of the American Orthopedic Association will take place in Rochester, New York, on June 7th and 8th, 1923. Professor

Denucé, of Bordeaux, will be present as the guest of the Association, and will present a paper on his method of treatment of congenital dislocation of the hip. Dr. R. R. Fitch will preside at the meetings.

The headquarters of the Association during the meeting will be at the Sagamore Hotel on East Avenue, and the sessions will be held in the Genesee Valley Building, on the corner of East Avenue and Gibbs Street, which is nearly opposite the hotel.

It is expected that the members of the Association and their guests will have an opportunity to hear the following papers:

The Pathological Changes in Tissues secondary to Disturbances in Circulation—Dr. Barney Brooks.

Old Congenital Dislocations of the Hip. Operatic Treatment—Dr. Frank S. Dickson.

Observation on Arthritis—Dr. Loring T. Swaim.

Review of Infantile Paralysis After the Acute Stage—Dr. Arthur T Legg.

Non-suppurating Osteomyelitis—Dr. M. S. Henderson.

Arm-Chest Adhesions—Dr. John Staige Davis (by invitation).

Recurring Lateral Dislocation of the Patella—Dr. William E. Gallie.

Patellapexy—Dr. Walter G. Stern.

Z-Plastic Surgery—Dr. Stewart L. McCurdy.

Origin and Changes of Loose Bodies in Joints—Dr. Dallas B. Phemister.

A Report of the First Forty-Five Cases of Scoliosis Treated by Fusion at the New York Orthopaedic Hospital—Dr. Russell A. Hibbs.

The Treatment of Compression Paraplegia of Pott's Disease—Dr. Charlton Wallace.

Anatomical Study of the Spine with Reference to Structure and Symptoms—Dr. Joel E. Goldthwait.

Some of the Causes of Low Back Pain—Dr. Murray S. Danforth.

Compound Fractures of the Femur and Open Fractures into Joints—Dr. William O'Neill Sherman (by invitation).

Simple Fractures of the Femur—Dr. Arthur M. Shipley (by invitation).

The Late Correction of Fracture Deformities of the Femur—Dr. H. Winnett Orr.

After-Care of Fractures from an Industrial Standpoint—Dr. Edwin W. Ryerson.

An Operation for the Correction of Plantar and Adduction Contraction of the Foot Arch—Dr. J. T. Rugh.

Operation for Drop Foot with Report of Cases—Dr. Willis C. Campbell.

The Author's Operative Method for the Correction of Hammer Toe—Dr. Robert E. Soule.

The Problem of Orthopaedic Surgery in China—Dr. E. G. Brackett.

On June 5th, two days preceding the regular meeting of the Association, for those members who wish to take advantage of the opportunity, there will be a Clinical Day held in Montreal. Arrangements for the day are being made by Dr. A. Mackenzie Forbes and Dr. W. G. Turner, and clinics will be held at the Children's Memorial Hospital and the Royal Victoria Hospital. Wednesday, June 6th, will be devoted to a trip by water through the Thousand Islands and Lake Ontario to Rochester, N. Y., which will be reached in the evening.

The fare from Montreal to Rochester is about fifteen dollars, including luncheon and dinner. Unless "Circular Tour" tickets are available from the city of residence, transportation should be taken to Montreal, and from there to Rochester, N. Y., by the Canada Steamship Company. If a sufficient number of the members of the American Orthopedic Association decided to go this way a reduction in the fare will be made.

It is hoped that a large number of the members of the Association will avail themselves not only of this most beautiful trip by water, but also of the Clinical Day to be held in Montreal. Further information may be obtained by writing to Dr. A. Mackenzie Forbes, Children's Memorial Hospital, Montreal.

Book Review

Orthopedic Surgery. By SIR ROBERT JONES, K.B.E., C.B., and ROBERT W. LOVETT, M.D., F.A.C.S. New York: William Wood & Company, 1923.

This new volume, the production of internationally known authors, writing from opposite sides of the Atlantic, represents the most instructive and comprehensive survey of the field of orthopaedic surgery yet attempted. It is the first time, so far as we are aware, that the adults' and children's phases of the work have both been properly presented in the light of recent progress. Modern literature has been carefully searched, and nothing that represents a definite advance, particularly in the operative field, has been omitted. References are made to fundamental articles, and the conscientious effort to credit work in each instance to the proper individual is exceedingly praiseworthy.

In providing the best text book yet obtainable for students, the approach to the various subjects is made in an original manner which avoids the orthodox method of considering each subject piecemeal without reference to related subjects, then dismissing it, and proceeding with the next. After first building up a solid foundation of fundamentals with a review of the anatomy, physiology, and pathology of the subject under discussion, the various topics are considered along broad general lines. Disease is considered as a reaction to unfavorable conditions, symptoms as clinical manifestations of pathological conditions, and treatment is discussed from the standpoint of meeting pathological requirements. This does not prevent the consideration of the various subjects from being meticulously detailed. This original method of approach, combined with the delightful literary style of the writers, makes the book easy and delightful reading, and will win for it many friends.

The main purpose of the book, however, is not as a text book, but as a guide to the general surgeon and practitioner, who, because of a limited experience in the conduct of so-called orthopaedic conditions, too often feel entirely helpless when confronted with a case requiring actual assistance. To them this book will prove a real delight. The encyclopaedic method is entirely lacking, and the authors' opinions are definitely expressed in every instance, and methods which they consider unsound or obsolete are completely omitted. Debatable matters are handled sanely with a consideration of both sides, but one is not left wondering as to which side the authors' opinions incline. Reference to the book with a case in mind more nearly approaches a consultation with the authors than is the case with any other book on the same subject. It was to be feared that widely divergent opinions of the writers on certain subjects might lead to compromise and lack of force, but so far as we can see this fault has been avoided.

From the standpoint of interest in a field of orthopaedic surgery that is constantly growing in importance—namely, the work dealing with the correction of faulty mechanics of the body—we cannot help wishing that some attention had been devoted, but perfection means different things to different persons, and certainly the reader, whoever he be, will find each of the 700 pages of this book teeming with interest, and its 712 illustrations clear cut and of valuable aid in explaining the text. The book represents a very notable achievement.

Current Orthopaedic Literature

TUBERCULOSIS.

ANKYLOSING OPERATIONS IN THE TREATMENT OF POTT'S DISEASE IN THE ADULT. DISCUSSED BY DR. ESTOR. *Presse Medicale*, Oct. 14, 1922.

This question, one of three taken up at the Fourth Congress of the French Orthopaedic Society (Paris, October 5, 1922), was discussed by Prof. Estor of Montpellier.

His conclusions were (1) that it was not indicated in children, but was logically employed in the adult, without, however, replacing a prolonged immobilization, usually three years; (2) the operation has given good results and should meet with greater favor in France; (3) the graft undoubtedly lasts strongly for some time; (4) the Albee method is one most generally adopted; (5) a bone graft influences favorably abscess formation, nervous complications, and pain, but he does not think it can have an influence in reducing the deformity.

Dr. Putti of Bologna did not evidence any enthusiasm over ankylosing operations, though recently returned from America. He preferred the Hibbs to the Albee operation.

Dr. Delchef of Brussels wished to know why children should not also be operated on, and emphasized the necessity of operating early.

Dr. Etienne Sorrel of Paris advised that ankylosing operations should be reserved for adolescents or adults in a late period of the disease. He recommended Albee's instruments as the best.

Dr. Lance of Paris spoke favorably of the Hibbs' operation, especially since he had used it in cases of paralytic scoliosis.

Dr. Mauclaire of Paris held that ankylosing operations should be used only in cases of advanced bone destruction. In dorso-lumbar and lumbar cases it was unnecessary and in cervico-dorsal or high dorsal cases it seemed to lead to meningitis and was, therefore, contraindicated.

Dr. Patel of Lyons reported a successful cure in a woman of thirty-five, brought about by an ankylosing operation.

Dr. Charles Martin du Pan of Geneva spoke favorably of heliotherapy and quoted successful cases in children who had had grafts.

Professor Estor closed the discussion.—*J. A. Nutter, M. D., Montreal.*

DISEASE. G. R. Girdlestone. *British Journ. of Surg.*, January, 1923, p. 372.

From a consideration of the nature of operative treatment of Pott's disease it is obviously not a short cut in treatment, nor should it be expected to replace the general hygienic measures which are always necessary in case of tuberculosis, no matter how far localized. It is of value only as a part of the conservative treatment of Pott's disease. The general indications for treatment are, first, raise the general level of health and increase the patient's resistive powers; second, obtain healing of the spinal lesion with re-establishment of sound structural stability.

Albee's operation apparently developed as an outgrowth of Brackett's observation that normal healing in Pott's disease was frequently accompanied by fusion of the posterior spinal arch. Albee wished by his graft to anticipate this fusion before the development of deformity. Hibbs stressed the necessity of eliminating all motion, feeling that this would hasten cure.

When the spine is considered from the standpoint of statics, it is obvious that the body is a weight-bearing portion, the spinous processes and transverse processes are the levers by which movement is obtained, and that under these circumstances the spinal articulations serve as fulcra to provide the means of securing leverage. Caries of the spine is accompanied by (1) telescoping, (2) inflection, with deformity.

The objective of spinal fixation and its rationale are to hold the weight-bearing portions or bodies apart by drawing the spinous processes together. It is essentially a splinting procedure; it is not intended that the union should resist cross breakage strain. The chief strain exerted is one of tension, so that there is not necessarily a comparison between the weight of the body and the strength of the graft.

Girdlestone reviews the various methods of operation and concludes that Albee's operation is successful in a large number of cases and is essentially less difficult than the Hibbs procedure. He has had no personal experience with the Hibbs operation and, although the reported results are excellent, he feels that the technique is difficult and the operation time-consuming, and that it would be necessary to spend considerable time at Hibbs's clinic to acquire the technique. He compares his own results in a hundred cases with Hibbs's reports of results in 210 cases.

Hibbs 210 cases. Cured, 157; op. mort., 0; doubtful, 22; dead, 31. 13 died miliary tuberculosis; 5 of tuberculous meningitis; 4, phthisis; 3, amyloid disease.

Girdlestone—100 cases. Op. mort., 2; later mort., 6. All but one died of tuberculous compl.

End-Results First 50, 1911, 18. Well, 42; last heard of well, but no recent report available, 5; with signs of persistent or recurrent disease, 1; dead, 8.

Last 41, 1919, or later. Healed and O. K., 36; psoas abscess but O. K., 1; with signs of persistent or recurrent disease, 4; dead, 0.

After-Treatment. The frame fixation was at first used for three months only, but in the case of children it has since been extended to six months. In the case of adults four months is sufficient, and the spinal support is worn for one year following this, and generally anti-tuberculous measures are employed. He feels an essential and important part of the after-treatment is the use of

an anterior plaster shell, which is used as a turning case, the patient being allowed to lie on that whenever the back is inspected, the back dressed, and heliotherapy employed. This is made before operation, and during operation the child is supported in it, a frame being built out to support the forehead and allow the easy administration of anaesthetic.—*P. D. Wilson, M.D., Boston.*

EARLY DIAGNOSIS OF JOINT TUBERCULOSIS. A. Kreeke. *Muench. Med. Woch.*, Sept. 29, 1922.

The absence of early characteristic signs of tuberculosis of joints frequently leads to wrong diagnosis and hence to inefficient therapy. Careful and repeated examinations, however, with due consideration of subjective and objective findings, must result in a proper diagnosis even in the early stages.

The patient complains of weakness and fatigue in the affected extremity. Parents of small children will state that the patients spare the affected parts, not using the arm or not carrying the full weight on the affected leg. Only after the lapse of some time will pain be complained of in the joint in question itself or in remote joints of the extremity, this pain being augmented, as a rule, after exertion. The objective findings should be gathered from an inspection of the patient entirely stripped. The affected extremity should be carefully inspected and compared with the unaffected limb. It is important at this time to carefully study the normal depressions and elevations recognizable about each joint. This is followed by exact comparison of both sides with the aid of a tape measure. Muscular atrophy above and below the joint is determined and seriously considered. The determination of active and passive motion of the suspected joint and the comparison of these findings with the normal side follow next. All movements are recorded by means of a goniometer. In passive motion the manifestation of pain at the termination of a completed movement, flexion, extension, ab- or adduction, inward or outward rotation, is always suspicious and must be noted carefully. Frequently the pain is accompanied by muscular spasm after this passive maneuver. The radiographic findings, although they are to be obtained, are not indicative of a tuberculous process in a joint. Very rarely will any change be noticed in the early stage. The general health of the patient must be considered, other organs, especially enlarged glands, examined, and the afternoon temperature for a number of days determined. The tuberculin reactions, intracutaneous and intramuscular, must be administered, although a negative result is not to be regarded as excluding a possible tuberculosis of the joint.—*I. Gottlieb, M.D., Los Angeles.*

DIFFERENTIAL DIAGNOSIS OF INCIPIENT TUBERCULOUS SPONDYLITIS AND CHRONIC RHEUMATISM OF THE BACK MUSCLES. C. Mau. *Muench Med. Woch.*, September 29, 1922.

Contrary to the deliberations of Pitzen in a recent article in the above journal concerning the uselessness of tuberculin reactions in a differential diagnosis of the two above-named affections, the author insists that tuberculin tests are by all means to be considered in the differential diagnosis of these

diseases. He values the reactions especially when, besides the Pirquet, the intracutaneous reactions prove negative, and when with a positive Pirquet, the temperature reaction, after subcutaneous injections of higher doses of tuberculin, remains negative. Spondylitis can then with certainty be ruled out. A positive temperature reaction plus a negative Pirquet, will not offer the surety that tuberculosis is absent, because a negative local reaction is not a guarantee against tuberculous infection. The statement that in spinal tuberculosis local reactions are more seldom seen than in other bone tuberculosis, the author contradicts on the basis of his accumulated material.—*A. Gottlieb, M. D., Los Angeles, Calif.*

CONGENITAL DEFECTS.

A SIMPLE METHOD OF TREATING CLUB FOOT (CONGENITAL TALIPES EQUINO VARUS). A. S. Blundell-Bankart. *British Med. Journ.*, December 9, 1922, p. 1115.

This method will be quoted in some details, as the article contains little more than the necessary description to be clear.

The deformity is corrected in the ordinary way by tenotomy, manipulation and splinting, plaster of Paris or other retaining material being applied for a week or two or even much longer when desired. Then comes the special "fixation operation," which consists of a silk ligature extending subcutaneously from the base of the fifth metatarsal bone to the lower third of the tibia, where it is fastened by being passed through holes bored in the latter bone and tied. This the author claims secures the foot against relapse and shortens greatly the course of brace or plaster treatment. The silk is passed through a hole in the base of the fifth metatarsal and brought around its outer side, where it is tied in a single knot. From this small incision a probe with an eye at the tip is passed up the leg subcutaneously to the lower third of the tibia where, through a second incision, a drill bores two holes through the tibia to its inner side, to come out through a third small incision. By a succession of loops in the eye of the probe the two ends of the silk ligature are successively brought from the foot up the leg and through the separate holes in the tibia and tied on its inner surface. The wounds are closed, later the stitches removed, and then two months in plaster, after which the ordinary shoe is used. This is certainly interesting, if it is only effective.—*C. A. Parker, M. D., Chicago.*

SPINA BIFIDA OCCULTA AND ITS SEQUELS. M. Hackenbroch. *Muench. Med. Woch.*, August 11, 1922.

The extensive literature on this subject during the last few years is enriched through this article by the report of operative findings and evident therapeutic success on a patient, a girl of 12 years of age.

Case history: Healthy family, healthy brothers and sisters. Since three years of age progressive crippling of feet. Since ten years of age considerable growth of foot deformity. Since childhood enuresis nocturna.

Findings: Normally developed child. Negative findings except those on the

spine and feet. At about the last lumbar vertebra, along the line of the spinous process, a tumor mass of 7 cm. long, 1 cm. wide, and 1.5 cm. high, palpable under the skin. The consistency was that of a doughy swelling, with possible fluctuation. The skin was movable over the mass, which seemed to be adherent to a bony base. On each side of the swelling the palpating finger could feel a projection similar to a spinous process. In the region of the third lumbar, above, and the second sacral, below, a depression was felt. No loss of normal sensations and no tenderness present. All reflexes normal.

The lower extremities presented outspoken claw and cavus feet. Up to the middle of the calf, the legs were cold and somewhat cyanotic. Passive dorsal flexion met with spastic resistance. X-ray revealed a gap along the third to fifth lumbar and first to third sacral vertebrae. Operation under general anesthesia. Incision over the last lumbar. On the place of the swelling a muscle appeared which on all sides was constrained in the tense spinal fascia. It gave the impression of normal muscle tissue. Above this the vertebral canal was opened and the process of the fourth lumbar resected. The exposed dura was firm, 1 mm. thick, and adherent to the vertebral arches by means of fibrous bands. After loosening the fibrous bands, the muscle mass was carefully dissected from its base. On each side of this mass appeared a kind of spinous process between which it lay imbedded and it was connected in the median line by a bone-like tissue. The mass was resected in its entirety. After this a lipoma appeared on the dura, the size of a cherry, enveloped in a thin connective tissue membrane, adherent to the dura and the vertebra. Closure of muscle and skin.

One hour after the operation, the livid appearance of the feet disappeared. Both feet and legs became normal in color and temperature. Primary union. Since the day of the operation the enuresis nocturna has been absent. The foot correction was performed one month later.

The findings of this case demonstrate: 1. Spina bifida is to be regarded as primary fetal malformation and not as resulting, secondarily, from an intrauterine disease process. 2. The difficulty of differentiating it from a meningo and myelocele.—*A. Gottlieb, M. D., Los Angeles, Calif.*

CASE OF OSTEOGENESIS IMPERFECTA. M. F. L. Keene. *Lancet*, September 23, 1922.

The case was that of a stillborn female child at the end of an eight-month pregnancy. The extremities as described and shown in the illustrations were very short and deformed. "The shaft of the long bones showed a fibrillated periosteum ruptured in places and containing a pulpy mass consisting of minute islands of osteoid tissue, marrow and osteoblasts, in very large number."

The subperiosteal bone was absent. There were feeble attempts at ossification in the membranous cranium and the ribs were entirely cartilaginous. The small size of the thymus was suggested as a factor interfering with bone development.—*C. A. Parker, M. D., Chicago.*

FORMS OF ARTHRITIS.

NON-TUBERCULOUS ARTHRITIS OF THE HIP. A. Broca. *Presse Médicale.* November 1, 1922, p. 941.

The writer points out that all hip arthritides center on the possibility of tuberculosis, and that not only are there numerous non-tuberculous arthritides, but tuberculosis itself varies in its intensity—whence the difficulty of diagnosis. He attaches little importance to the tuberculin reaction, save when negative. 1. In speaking of caput planum (Legg-Calvé), he does not think it due to malformation of the acetabulum, nor to trauma, there being no history of this in his 10 cases. 2. Speaking of mild cases of arthritis with a limp, he insists that it is impossible to differentiate these at once from tuberculosis, and points out that even tuberculosis may present intermittent periods of freedom from symptoms. He advocates in doubtful cases two weeks' rest in bed and two weeks on the feet. If signs still persist we know that a chronic arthritis is present, of which tuberculosis is the probable cause. Of the non-tuberculous cases, some may be "growing pains," others luetic, and others may turn out to be caput planum. 3. Sudden dislocation, almost always iliac, is special to the hip. It is sometimes preceded by an acute arthritis, and the x-ray may show no bone lesion. It should be reduced at once. This may be due to tuberculosis, typhoid, influenza, or to an osteomyelitis. Another lesion due to osteomyelitis is separation at the epiphyseal line, the head remaining in place, the neck dislocated upward. 4. In acute arthritis the difficulty is to decide whether pus is present. The general signs and the use of an exploring needle help to differentiate this from an acute rheumatism. Acute suppurative arthritis, the result of osteomyelitis, should be treated by resection of the femoral head for drainage, whether the head be infected or not. It is frequently seen in nursing infants and is generally very severe when caused by staphylococcus or streptococcus, but benign when caused by the pneumococcus, which type of infection is happily more frequent. Free drainage is necessary. 5. In speaking of chronic hip arthritis suspected of tuberculosis, but without definite proof, Dr. Broca says we know little of syphilis of the hip. He notes, however, that bilaterability, a sign of syphilis in the knee, is here often a sign of tuberculosis in hip conditions. In discussing caput planum, he evidently holds that some cases, at least, are tuberculous in origin. He notes three cases of caput planum following chickenpox, with complete restoration of the structure and function of the hip. 6. In closing, he speaks at length of the difficulty of differentiating between tuberculosis and osteomyelitis, quoting a case in point, where the latter disease finally made its presence certain by the discovery of a typical focus, with sequestrum, in the humerus. He speaks of rapidly spreading tuberculosis which simulates tuberculosis and of a differential diagnosis between tuberculosis and non-suppurative osteomyelitis, with x-rays giving no assistance, made by the aspiration of a few drops of sterile fluid. He has made his diagnosis in general by watching the case for years, when the presence of a cold abscess or of a sequestrum has cleared up the diagnosis.—*J. A. Nutter, M.D., Montreal.*

NEUROPATHIC ARTHRITIS. John H. Duncan. *Jour. Amer. Med. Assn.*, December 9, 1922, p. 1987.

When any nervous structure is injured by trauma, infection, or toxins, reflex arcs are disturbed, the permanency of the condition depending on the cause. Skiagraphs of teeth showing absorption, clubbing of roots, and hypertrophy in a patient who suffered the removal of the Gasserian ganglion are shown. When the efferent nerves are destroyed the result is atrophy, but when the afferent nerves are destroyed the result may be either atrophy or hypertrophy.

A case showing injury to afferent nerves is described where a log had fallen on the patient's right shoulder.—*Edward S. Hatch, M.D., New Orleans.*

UNUSUAL CASE OF STILL'S DISEASE. H. Schneiderman. *Missouri State Med. Assn. Jour.*, November, 1922.

Still was the first to describe a type of rheumatoid arthritis in children characterized by a progressive enlargement of the joints, lymph glands, and spleen. The onset is usually before six years. The progress is slow, with stiffness of one or more joints. There is a gradual enlargement with thickening of tissues. The enlargement is not bony. There is no effusion or suppuration. Limited motion, rigid flexion, but no ankylosis of joints. Muscle atrophy is present. The glands next the affected joints become enlarged. The prognosis is fatal.

The author discusses a case, age 15 years, which gave the chief complaint of blindness, deafness, and tremendously enlarged lower extremities. The personal and family history were negative. At the age of six years the left knee began to enlarge without fever or other systemic disturbances. The other joints began to enlarge until the age of 11, when all joints of upper and lower extremities were enlarged and rigidly flexed. October, 1920, lower extremities from knees to toes began to swell. Lost hearing; then few months after she lost her sight. Heart showed great enlargement. There was a systolic murmur at the apex. All the joints of the upper limbs were enlarged, tender, and rigidly flexed. The legs gave the picture of elephantiasis and were covered with foul-smelling ulcers. The blood picture was one of secondary anemia. The blood and spinal Wassermann were negative. The x-ray examination showed thinning of the bone shafts, enlargement of the heads of the bones, with thickening and calcification of the soft parts around the joints. The legs were amputated above the knee on account of the necrotic condition of the soft parts. The autopsy findings were important in that there was no evidence of tuberculosis or syphilis.

The author points out that his case resembles Still's description, aside from the unusual feature, namely, elephantiasis.—*Voigt Mooney, M.D., Pittsburgh, Pa.*

CHRONIC NON-TUBERCULOUS ARTHRITIDES OF THE HIP IN CHILDHOOD. (Third question discussed at the Fourth Congress of the French Orthopaedic Society.) Dr. Etienne Sorrel. *Presse Médicale*, October 11, 1922.

Dr. Sorrel described: (1) hemophilic arthritis; (2) traumatic arthritis following fractures, coxa vara, coxa valga, and congenital dislocation; (3) arthritis accompanying infectious diseases, as pneumonia, scarlet fever, smallpox, measles, typhoid, syphilis, gonorrhea, osteomyelitis; (4) dry arthritis deformans, more frequent in adolescence than has been thought; (5) osteochondritis deformans (Legg-Calvé).

On this latter subject Dr. Sorrel spoke at length. It had been suspected by Kirmisson and others before it was discovered and given a name by Legg of Boston and later by Calvé (Berck) and Waldenström, the latter considering it tuberculosis of the neck of the femur. It is generally seen in boys of five to nine years and is rarely bilateral. Its pathologic anatomy is little known and almost wholly through x-rays. The epiphyseal disc is flattened and may be fragmented; the femoral neck is often thick; coxa vara, as a rule, is not present. The onset is insidious, with pain and limp on walking. Its course is benign, leading neither to ankylosis nor to arthritis deformans. As to cause, Legg's traumatic hypothesis is not proved. Is it congenital? (Murk Jansen.) Sorrel thinks it is inflammatory in origin, but cannot indicate the source. The endocrine glands have been thought the cause, as with inflammation of the scaphoid bone of the foot, and hereditary syphilis has also been considered.

Dr. Nové-Josserand (Lyons) discussed the relationship of osteochondritis with arthritis deformans juvenilis and with coxa vara. He thinks them all forms of the same disease, with different anatomic aspects.

Dr. Froelich of Nancy described: (1) dry progressive arthritis with congenital hip dislocation; (2) arthritis with progressive deepening of the acetabulum; (3) osteochondritis (Legg-Calvé), which latter is a form of epiphysitis, together with essential coxa valga.

Dr. August Broca (Paris) deplored the vague term coxalgia as leading to confusion. He thought that some cases of osteochondritis (Legg-Calvé) were of a tuberculous nature.

Drs. Albert Mouchet and Carle Roederer make no distinction between osteochondritis and osteoarthritis in childhood, thinking them probably identical.

Dr. André Rendu (Lyons) reported cases of osteochondritis following trauma and one case following rickety deformities.

Dr. Vignard (Lyons) told of arthrotomies in two cases of osteochondritis. From one he removed two small fragments of bone of ivory hardness resembling sequestra. In the other case nothing particular was found. Dr. Vignard considered these cases showed plainly that osteochondritis was neither due to an incomplete hip dislocation nor to a congenital deformity of the acetabulum.

Dr. Judet (Paris) divides non-tuberculous hip arthritides into: (1) traumatic, (2) congenital abnormalities, (3) essential coxa vara, (4) those due to infections, (5) those of unknown origin, possibly due to hereditary syphilis or an attenuated tuberculosis.

Dr. Lance maintained that osteochondritis could lead to permanent deformity, as opposed to Dr. Sorrel's opinion that it never did so. He was also impressed by the rôle of congenital syphilis as a causative agent.

Dr. Kirmisson spoke of the relationship of coxa vara with adiposity and thyroid insufficiency.

Dr. Froelich of Nancy thought the epiphysitides of the period of growth were due rarely to trauma, but generally to systemic infection, with or without the influence of the endocrine glands.—*J. A. Nutter, M.D., Montreal.*

SCOLIOSIS.

OPERATIVE TREATMENT OF SCOLIOSIS. Samuel Kleinberg. *Arch. of Surgery*, November, 1922.

Nineteen cases of structural scoliosis between the ages of eight and twenty have been operated upon by the author in the last two years. Treatment consists of: (1) the preoperative stage, consisting of four to eight weeks' recumbency and stretching of the trunk on a gas-pipe frame; (2) the operation, which is a combination of certain features of the Hibbs, Albee, and Forbes ankylosing operations, using a beef bone graft; (3) the postoperative stage, consisting of ordinary recumbency in bed for a week, then replacing on the frame with traction, as before, for about eight weeks, followed by an ambulatory jacket for several months.

Conclusions are that this method is a distinct improvement in the management of this troublesome condition; that the beef bone graft has many advantages and has not had to be removed in any of his cases, probably because of especially careful preoperative preparation; that the maximum possible correction of the deformity is quickly obtained by the preoperative management and can probably be permanently maintained by the operation and the comparatively short period of after-treatment. However, it will require several years for final proof of this.—*R. W. Billington, M.D., Nashville.*

SCOLIOSIS. Alexander MacLennan. *Brit. Med. Jour.*, November 4, 1922, p. 864.

MacLennan enumerates the "various ostensible causes" of scoliosis under the following heads: heredity, osseous defects, rickets, tuberculosis, fractures, tumors, osteoarthritis, paralysis, syringomyelia, Friedreich's ataxia, hemiplegia, spastic paraplegia and poliomyelitis, muscular weakness, muscular spasm, secondary to wry neck, postural, empyema, inequality of length of legs, gravity.

As to the theory of development, he considers the rotation as a necessary mechanical result of unequal growth in vertical length of the bodies and the arches representing respectively the anterior and posterior sections of the compound upright column. Inefficient growth of the anterior part, or the bodies, results in kyphosis, while inefficient growth of the posterior portion—the arches—increases lordosis, a result easily attained in the cervical and lumbar regions, but not so easily attained in the dorsal region, where lateral projection of the unequal growth takes place. He favors the Abbott method for forcible correction and also favors operation in selected cases—not after 15 years, when the deformity is apt to be fixed. The operation is as follows: "A four inch incision

is made over the convexity of the curve. It is placed just external to the tips of the transverse processes. The dissection will vary according to the locality, but the muscles are split rather than cut. The posterior nerve branches are conserved as far as possible, as their division is liable to be followed by the development of a hyperaesthetic area just where subsequently sustained pressure is required to be made. Two, or at most three, ribs are resected from their angles to their articulations with the vertebrae. The pleura is very liable to injury, and the wound retractors should be wrapped in gauze to minimize this risk. The tissues over the vertebral bodies are raised from the lateral fossa, avoiding injury to vessels or nerves. On account of the deflection of the vertebral bodies towards the convexity they are much more accessible than would be expected.

"The body of the vertebra forming the center of the curve is excavated and the same is done to the vertebra above and below, though not to so complete an extent. The intervertebral substance is nibbled or cut away. With the finger in the cavity so made, the spine is forcibly flexed towards the convexity. The wound is closed in layers, without drainage. A plaster of Paris jacket is applied with the spine flexed laterally as much as possible." Finishing the description of the operative procedure, he says: "Having obliterated the growth of more than one vertebral epiphysis the distortion will tend to reduce as the posterior part of the spine increases in length." He does not say how many cases he has operated upon, but states that, "In the cases so operated upon I have been more than satisfied that the risk involved is compensated for by the improvement."—*C. A. Parker, M.D., Chicago.*

Observations on the Corrective and Operative Treatment of Structural Scoliosis. Armitage Whitman. *Arch. of Surgery*, November, 1922, p. 578.

This is a summary of three years' experience with a new operative method used at the Ruptured and Crippled Hospital, New York. The author deals with the so-called "idiopathic scoliosis," with fixed, structural deformity. He applies plaster jackets after the method described by Kleinberg, with the patient suspended, using lateral pulls holding down the high shoulder, and cutting a window over the concavity. As much correction as possible is obtained in this manner. The problem then is to maintain the correction obtained and this is done by a fusion operation on the spine rather than to attempt to maintain the correction by wearing jackets or braces over a period of years. First operation was performed June, 1920. Since July, 1920, 15 patients have been operated upon. When the corrective jackets are removed the patient is put upon a convex stretcher frame supported above the bed for a few days, to accustom the patient to this position and to prepare the skin for operation. A fusion operation is then performed on the spine. As soon as the postoperative discomfort is over, traction is applied to the head by a Sayre suspension and to the pelvis by a belt and straps passing over the foot of the bed. Weights are gradually increased up to 20 pounds on the head and 30 pounds on the pelvis. Some-

times lateral traction is applied against the convexity of the ribs to aid in correcting the deformity. The time consumed in the operation is from an hour to an hour and three-quarters. There is considerable shock. There have been no deaths or infections. The patient remains on the frame for two months. A short strait-jacket is then applied, which is worn for about two months or longer, depending upon the strength of the patient. The operation is a combination of the Hibbs and Forbes operations, attempting to get as much fusion as possible.

The author states that he hopes no wave of enthusiasm for "operative treatment of scoliosis" will develop. The operation is only a final step in a tedious process of correction and offers little that is new unless it is the principle of balance on which it is performed. It should not be urged upon the patient. It is essential that the patients themselves be desirous of the treatment and willingly and actively coöperate in the treatment. There follows a report of 11 cases with photographs and roentgenograms.—*F. G. Hodgson, M.D., Atlanta, Ga.*

FRACTURES AND DISLOCATIONS.

THE DELBET WALKING PLASTER FOR TREATMENT OF DELAYED UNION IN FRACTURES OF BOTH BONES OF THE LEG. LeRoy C. Abbott. *Arch. of Surgery*, November, 1922, p. 485.

Delayed union is common in fractures of both bones of the leg, especially those in the lower third. This method of treatment is safer, simpler, and produces better functional results than operation and fixation, especially with metal plates. The bone ends are stimulated by use to better callus formation, the circulation of the limb is improved, the muscle strength and joint motions are improved.

The apparatus consists of moulded plaster of Paris splints applied next to the shaved and greased skin, two lateral splints from the sole to the knee, and held together by circular bands just below the knee and another at the ankle. The plaster must be very smooth and carefully moulded to the tuberosities and malleoli while it hardens. The patient walks first with crutches, then with a stick only. Splints are changed about once a month. Roentgenograms are taken every six weeks to observe the callus production. In three to five months consolidation usually occurs. Diagrams showing the method of preparing and applying the splints are shown. Four cases are reported with serial x-rays showing the development of callus and the final results. They are quite convincing.—*F. G. Hodgson, M.D., Atlanta, Ga.*

THE PROGNOSIS OF FRACTURES. Astley P. C. Ashhurst. *Surg., Gyn. and Obstet.*, November, 1922.

In an editorial Dr. Ashhurst calls attention to the rapidity with which fractures in children unite as compared with those in adults, that the impairment of function differs according to the bone that is broken and according to the location of the fracture in that bone. He holds that, as long as function is good, poor position as shown by the x-ray may be ignored. He deplores too long absolute fixation.

He advocates prompt and accurate reduction, early active motion consistent with good apposition, and care and attention to the soft parts and skin.—*H. A. Pingree, M.D., Portland, Me.*

TREATMENT OF FRACTURED CLAVICLES. W. L. Bell. *Annals of Surgery*, November, 1922.

In order to obtain more stable fixation than is usually obtained with Sayre's, Velpeau's, adhesives, staves, Brown's shaped sheet metal, etc., the author uses plaster of Paris. A chest cast is made first to secure a permanent holding foundation. Then the arm is enclosed in plaster to the elbow. Finally, on the following day, with the body cast as a base and a stable foundation, the arm and shoulder joint carrying the outer clavicular fragment is extended, with counter pressure against the chest cast, outward, upward, backward. When the outer fragment is properly elevated, extended and placed, a wiped joint of plaster of Paris is applied around the gap between the arm and body cast and this position scrupulously maintained until the extension ring or wiped joint has thoroughly set. Slight abduction of the arm facilitates placing the circular plaster which covers ample chest, axillary and arm padding.—*E. Z. Holt, M.D., Atlantic City, N. J.*

FRACTURE OF THE TIBIAL SPINE: AN EXPERIMENTAL STUDY. Frank E. Blaisdell, Sr. *Arch. of Surgery*, November, 1922.

After a consideration of the normal functions of the crucial and periarticular ligaments of the knee, the author gives the results of force applied in various directions to the knees of cadavers, with special reference to injuries to the tibial spine without serious damage to other structures.

Force applied on the front of the lower part of the thigh, driving the femur backward on the tibia, produced rupture of the anterior crucial (greater force rupturing both crucials), fracture of the tibial spine or avulsion of a fragment of the femoral condyle at the anterior crucial attachment. Similar results were obtained when the force was applied to the posterior aspect of the upper part of the leg, the thigh being fixed. Similar effects on the posterior crucial and its bony attachments were produced when the direction of forces against femur and tibia were reversed. These effects were produced without serious damage to other structures.

Violence applied laterally was found to result in a complicated injury-fracture of femoral condyles, tibial tuberosities, or fibular head, crucial triad involvement, with dislocation of knee in varying degrees. Inward rotation of leg on thigh, with knee more or less fixed, may result in injury to the lateral meniscus or may involve the crucial triad.

Outward rotation of the leg, with the knee more or less fixed, may lacerate the medial meniscus or involve the crucial triad.—*R. W. Billington, M.D., Nashville.*

Treatment of Disabilities of Hand and Wrist: Anatomic Review in Relation to Function. W. A. Cochrane. *Edinburgh Med. Jour.*, September, 1922.

Cochrane emphasizes the necessity of being familiar with the detailed physiology of the hand in the care of its injuries and diseases in order to reduce the resulting disabilities to a minimum. He discusses the necessity for preserving as far as possible the anatomic form and the best positions for function, directing particular attention to the action of the thumb as controlled by the opponens pollicis. Where this action is destroyed, he favors an arthrodesis of the carpometacarpal joint in the position of abduction and opposition to the fingers. In Colles fracture he recommends the Cotton-Loder position of correction, flexion of the wrist and pronation of the radius around the head of the ulna. For stiff fingers he suggests long-continued extension of fingers by means of cords fastened to the fingers with tapes and attached beyond the tips of the fingers to a hoop splint supported by the forearm. This he claims opens up joint spaces and makes the ligaments more pliable. The author has done well to present this important matter of hand injuries to the profession, as it is far too frequently the practice in general hospitals to pass such treatment over to the junior surgeon or interne as a matter of little moment or a good chance for the young surgeon to get some practice. Often at such a fearful cost to the patient!—*C. A. Parker, M.D., Chicago.*

Forward Dislocation of Both Bones of the Forearm at the Elbow: Review of the Recorded Cases and the Literature with Report of Case. Isidore Cohn. *Surg., Gyn. and Obstet.*, December, 1922.

Dr. Cohn has given us an extensive and very interesting résumé of the subject, dating back to 1787. He gives a report of 16 cases, including one of his own. He also quotes six cases from the literature which were complicated by fracture of the olecranon process. The reports are much detailed and very interesting when we think that the findings in some of them were made over 125 years ago, and in almost all of them before the discovery of the x ray. The entire article is well worth reading. There are five radiographic illustrations. Dr. Cohn's conclusions follow:

"Anterior dislocation of both bones of the forearm is rare. Only 23 cases, in-

cluding the case herewith reported, have been found in a review of the literature. In all cases which have been verified by operation or autopsy there has been an extensive laceration of the ligaments about the joint and a stripping up of the muscles in the immediate vicinity from the respective bones.

"Anterior dislocations of the elbow may be either uncomplicated, or associated with a fracture of the olecranon or coronoid process. A review of the literature suggests that some of the cases have been reduced with very little difficulty.

"The case which forms the basis of this report showed that there was an extensive stripping up of muscles and interposition of soft parts between the lower end of the humerus and the ulna. Such a condition shows the impossibility of a non-operative reduction, particularly if seen late, as in this case.

"The approach to the elbow in such instances had best be done by lateral incisions rather than the linear posterior incision or the method recently suggested by MacAusland. The position after operation had best be one of complete extension, because the olecranon in complete extension is fixed in the olecranon fossa behind the trochlea. If the elbow is put in hyperflexion there is a tendency of the olecranon to slip forward again and reproduce deformity. After a few days it is advisable to begin mobilization of the joint."—*H. A. Pingree, M.D., Portland, Me.*

RESULTS OF TREATMENT OF FRACTURED FEMURS IN CHILDREN, WITH ESPECIAL REFERENCE TO BRYANT'S OVERHEAD TRACTION. W. H. Cole. *Arch. of Surgery*, November, 1922.

Of 35 cases, four were pathologic and 31 were simple fractures, 18 of which were treated by overhead traction. In the upper third there were three cases, all transverse. In the middle third there were 21, six being transverse, 14 oblique, and one greenstick. In the lower third there were seven, six being transverse, and one oblique.

Overhead traction has the advantages of simplicity of application and after-attention, comfort, and cleanliness, especially for the very young. It is advised in all types up to the age of about 10 years. Coaptation splints are also applied. Traction is by the usual adhesive plaster and cord passing through two pulleys on an overhead bar, one pulley directly above the hip and the other at the foot, so that the weights are out of reach of the patient.

All cases treated by this method are said to have obtained satisfactory functional results, though in several there was some overlapping or other imperfect apposition of fragments, especially in the transverse cases. Six of these cases were examined two or more years later and showed marked improvement in X-ray appearance. Cases healing with slight overlapping later show no shortening. The author speculates as to where and when this compensatory lengthening takes place and seems to think it is the result of the traction on the soft growing bones. However, there is no comparison of measurements taken at the end of treatment with those taken after two or three years. *R. W. Billington, M.D., Nashville.*

THE COMBINED TREATMENT OF FRACTURES OF THE SHAFT OF THE FEMUR. E. L. Eliason. *Surg., Gyn. and Obstet.*, October, 1922.

Dr. Eliason treats his fractured femurs by means of Sherman bone plates and screws in conjunction with plaster of Paris and traction. The leg and thigh are both maintained at about 50 degrees flexion to produce muscle equilibrium. He goes very minutely into the details of the operative work, and leaves in a drain. Apparatus is kept on for seven weeks, and complete weight-bearing is allowed in six months. A report of 13 cases is given, which is illustrated with 23 excellent cuts. Dr. Eliason's summary and conclusion follow.

"SUMMARY.

"1. In the 11 operative cases all were drained and no infections occurred.

"2. No case had a bad result; the greatest shortening was one-fourth inch.

"3. But one plate had to be removed and that was due to two errors, *i.e.*, too large a fenestration and no traction.

"4. The follow-up reports after months, and in a few cases, years, show no changes for the worse, and no plates have had to be removed.

"5. Every one of the 13 patients had a first-class limb, with no limps and joint limitation, but slight in two cases.

"CONCLUSION.

"Judging by this small series, the best treatment for fracture of the shaft of the femur is the continued use of internal and external fixation in the full sense of the word. It gave 100 per cent. good results."—*H. A. Pingree, M.D., Portland, Me.*

SNAPPING SHOULDER AND VOLUNTARY SHOULDER DISLOCATION. Max Kappis. *Arch. f. Orth. u. Unfall-Chir.*, 1922, xx, 4 H., p. 535.

Author reviews 13 cases as reported in the German literature as voluntary dislocations that he concludes are shoulder snappers. The displacement takes place with a snapping noise and depends mostly on the fact that the joint is brought *in toto* by voluntary muscular activity into an abnormal position, whereby it is shoved under a stretched muscle, usually backward. With disease or paralysis of the muscles, such an occurrence can become habitually involuntary. The cause of the abnormality is frequently congenital, but appears later in life. The muscles that cause the snapping movement of the shoulder joint vary in different cases, but there is usually some weakness of part of the deltoid muscle. The diagnosis is simple. The x-ray, at any rate, will show normal joint relations in every position. The prognosis is good. There are no complaints of any importance. The abnormality apparently disappears of itself in the course of time with decreased use of the muscle and lessened bodily cleverness. All therapy, therefore, is superfluous, with voluntary shoulder snapping. An apparatus can be worn if it ever becomes necessary. Operative interference consists of better fixation of the scapula to the clavicle either by reinforcement of the ligaments between them or by ankylosis of the acromioclavicular joint. Of course, this results in severe disturbances in function.

Habitual luxations at times can be voluntarily produced, but only seldom can they be voluntarily reduced and cause a snapping. True voluntary luxations are very rare, and like habitual voluntary luxations are only possible with severe joint injury. In addition there is a form of shoulder snapping produced by the checking of the normal joint motions by some intra or extra-articular causes which are overcome by a sudden snapping.—*Armin Klein, M.D., Boston.*

EXPERIMENTAL STUDY OF THE HEALING OF FRACTURES. Leonard W. Ely. *Arch. of Surgery*, November, 1922, p. 527.

This study was undertaken to clear up several obscure points in the process of healing of fractures, but chiefly to ascertain the exact rôle assumed by the periosteum. Three sets of experiments were performed on the humeri of cats. Series 1. The bones were fractured by direct violence, using the hands. Series 2. An incision was made, the periosteum was divided circularly and the bones cut. Series 3. Similar to the second except the periosteum was slit longitudinally and the bone cut across. Author reports in detail the microscopic autopsy findings in 14 cats in Series 1, six in Series 2, and six in Series 3. The cats were killed at various periods from four days to 11 weeks. In his comments he states that in none of the slides was there any evidence of any active part taken by the periosteum in the actual formation of new bone, and yet the periosteum must play an important rôle of some kind, for where it was divided there non-union regularly resulted. He states that periosteum is composed of fibrous tissue, and nothing like a second layer (cambrium) can be made out. He then discusses various theories about bone formation.

CONCLUSIONS.

1. The periosteum has a function to perform in the healing of fractures.
2. The ossification of the soft callus takes place from the external aspect of the cortex: These conclusions are elaborated. This is an excellent piece of experimental work and should be read by all who are interested in this much discussed and still unsettled question. *F. G. Hodgson, M.D., Atlanta, Ga.*

DISLOCATION OF THE SEMILUNAR CARPAL BONE. Harry B. Knapp. *Jour. Amer. Med. Assn.*, December 9, 1922, p. 1992.

The anatomy, frequency, symptoms, and diagnosis of this condition are taken up and the treatment is outlined. Prolonged hot application followed by bloodless reduction generally accomplishes cure. Open operation is successful by the use of the Davis skid; excision is practically obsolete. One case treated by open operation is reported.—*Edward S. Hatch, M.D., New Orleans.*

SUBASTRAGALOID DISLOCATION OF THE FOOT. Beveridge H. Moore. *Surg., Gyn. and Obstet.*, December, 1922.

Dr. Moore gives the history and occurrence as they appear in the medical

literature of the past. From his statements we may conclude that it is a relatively infrequent result of injury, and by experiment it has been shown that fracture is more likely to occur than ligamentous rupture.

Dr. Moore reports three cases which occurred in his own practice, and two of these were of many years' standing. The injuries and symptoms are carefully described, and the treatment covered briefly. The functional result in each case was most satisfactory. The paper is illustrated by means of four excellent photographs. Dr. Moore's own summary follows:

SUMMARY.

Subastragaloid dislocation of the foot is a rare injury, alternative with abduction and adduction fractures in the region of the ankle.

The physical signs of subastragaloid dislocation outward are eversion and abduction of the foot, with prominence of the head of the astragalus on the inner side of the foot. In old cases there is lowering of the malleoli and thickening of the foot below the malleoli.

Treatment in recent cases is reduction, either open or closed, as may be indicated. Total astragalectomy gives good results in old cases.—*H. A. Pingree, M.D., Portland, Me.*

FRACTURED CLAVICLES. T. K. Richards. *Jour. Amer. Med. Assn.*, November 25, 1922, p. 1839.

The method here advocated is a slightly modified clavicular cross, or T splint. The width of the cross bar of the T is of a width corresponding to the width of the shoulder at the axilla and of a length about two inches shorter than the width across the shoulders. There is no padding over the shoulders where the straps or bandages hold the shoulders to the cross bar; instead, webbing straps from 1 to 2 inches wide (according to the patient, adult or child) are used, over which have been slipped pieces of heavy rubber tubing from one-half to three-fourths inch in diameter and about 8 inches in length. The whole apparatus is in one piece and can be applied by one pair of hands.

It enables the patient to be up and about with nearly full use of his arm.

It does away with any danger of injury to nerves and blood vessels from tight bandaging.

It is comfortable, easy to keep clean, and prevents the chafing of the skin.

When the apparatus is removed, the function of the shoulder, as well as the other joints of the arm, is present, and the minimum time is lost before the patient can resume his daily work.—*Edward S. Hatch, M.D., New Orleans.*

FRACTURES OF THE TIBIAL SPINE COMBINED WITH FRACTURES OF THE TUBEROSITIES OF THE TIBIA. James Warren Sever. *Surg., Gyn. and Obstet.*, November, 1922.

Dr. Sever gives a brief consideration of fracture of the tibial spines, and the general symptoms connected with such injuries.

He then reports eight cases, from which it would seem that fixation in exten-

sion for many weeks, followed by baking, motion, and massage, will in the course of a year or more result in a very useful joint. Having in mind the severity of the injury and the simplicity of treatment, one is impressed by the very satisfactory function which is obtained.

The paper is illustrated by means of 11 half-tone pictures of radiographs.—*H. A. Pingree, M.D., Portland, Me.*

COMPRESSION FRACTURES OF LOWER END OF RADIUS. J. H. Stevens. *Annals of Surgery*, November, 1922.

Colles fracture of the wrist is called compression fracture of the lower end of the radius.

Impaction does not exist, but the real pathology consists of a crumpling up of the posterior cortical surface of radial bone, a crush which permits a reversal of the plane of the inferior radial articular surface.

In the type showing clearly the effect of a tremendous compression, the distal fragment is displaced backward, and the so-called impaction is clearly in evidence. There is always a crushing of cortical bone on the posterior or posterior and external side of radius. If an x-ray of these cases is taken after reduction, although the fragments are perfectly movable under the fingers, nevertheless, the x-ray demonstrates that the reversal of the antero-posterior angle or plane of the inferior articular surface of the radius, which is normally between 14 and 22 degrees in front of a line erected at the level of the anterior edge of the radius, still remains in all the cases of the serious type. In other words, the antero-posterior plane of the radial articulation has been reversed, and in all of the cases remains reversed, even after reduction.

What do we mean by reversal of the antero-posterior angle? On an x-ray plate of a lateral view of a normal wrist, draw a line straight down the middle of the shaft of the radius. At the level of the anterior inferior edge of the radial articular surface, let us erect a perpendicular to this first line and carry it through this line an equal distance posteriorly. We shall find that such a line cuts the posterior surface of the radius some distance above the articulation. In other words, the normal plane of the articular surface is anterior to this line. Now if we draw another straight line, beginning at the anterior inferior edge of the radius at the same point anteriorly where we began to erect our perpendicular, and draw it just touching the edge of the posterior inferior articular surface of the radius, we shall find that this last line, representing the slant or plane of the inferior radial articular surface will always form an angle with our perpendicular of from fourteen to twenty-two degrees of the arc of a circle, and that this angle is always in front of the perpendicular. This, then, is the normal antero-posterior angle of the lower radial articulation, and it is usually about eighteen degrees.

The angle measured in the x-ray plate of a crush fracture shows that it is reversed; in other words, the line representing the plane of the articular surface which in the normal was fourteen to twenty-two degrees in front of the perpendicular line is now behind it, and often an equal distance behind, and even after so-called reduction this reversal of angle persists. There has been

an actual destruction of bone on the posterior surface of the radius and the inferior fragment has consequently tipped backward and has been displaced in this direction. It is held rigidly by the bow-string tension of all the extensors, as we pointed out in the article before mentioned. The classical reduction releases the tension of these bow-strings, and with comparatively little force the distal fragment can be moved forward approximately into its normal position. The fragment is freely movable. The silver fork deformity has disappeared, and apparently there has been a perfect reduction. An x-ray is taken and a good reduction is reported, principally because the shaft of the radius seems to be in fairly good alignment. Little attention in our experience is paid to the fact that there still persists a reversal of the normal antero-posterior angle of the inferior surface of the radius. Now if this were due to impaction, the impaction obviously having been broken up, a freely movable fragment resulting, there would now be no evidence of this so-called impaction.

The unlocking of the inferior fragment of the broken radius is easily accomplished by hyperextension, thus releasing the bow-string tension of the thumb extensors, the extensor carpi radialis longior and brevior, the extensor indicis and the tendons of the common extensors of the fingers. Local pressure over the fragment with the thumb, traction, and then strong flexion of the wrist with the fingers extended, flexing the wrist to a right angle. This is the important movement in reduction, and flexion afterwards will be exactly proportionate to that degree of flexion which is attained forcibly at the time of reduction. Circumduction movement is of no importance, but a strong adduction should always be used to reduce lateral displacement and in order to restore the lateral angle which is often disturbed. In the majority of cases this will suffice for the reduction, but, nevertheless, they will still show the reversal of the antero-posterior angle, and sometimes to a tremendous extent. While we can return these wrists to practically the normal range of motion, almost as quickly as the apparently much less seriously injured, nevertheless, with this persistence of reversal there must always be at least a slight deformity on the front of the wrist, and a slight limitation of flexion.

We have reduced the fracture, the inferior fragment is freely movable, and we have pushed it forward into place. Remember that nearly always the fragment is permitted to remain too far posteriorly. The operator is afraid of pushing it to the front too far, and therefore often he fails to fully reduce. Push it forward firmly. Flex the hand to the limit at right angle to the wrist. Adduct to the limit to restore the lateral plane of the articulation; mould locally with the fingers, and put on the posterior splint—angled 40 degrees flexion and 30 degrees adduction. Take an x-ray, immediately, for verification. A wrench may be used, but never until after the bow-string tension has been released. It is the last thing to use in order to obliterate the last vestige of reversal of angle. It is never to be used as an instrument for reducing the fragment.

The most essential feature of the treatment of a fracture of this type is motion quickly, as we have pointed out many times. Motion is begun in these cases not later than the fourth day, but the posterior splint is left in place during the motion, the hand to the wrist being freed and moved gently in

flexion and adduction. Extension in these cases is not carried beyond the posterior splint, until after seven or eight days, and even then the wrist is not extended beyond the horizontal plane for some days longer. By this time there has been a filling in of the posterior gap in the bone by soft callus, and it is sufficient to retain the position. Abduction is left to the last. By even a few degrees of motion one can accomplish almost as much as by the fuller arc which is employed in all cases not showing this angle of reversal.

In an ordinary fracture of the lower end of the radius with any retention or restriction apparatus after the tenth or twelfth day, except a leather wrist strap, is a case maltreated. This is true of nearly all of these cases, but in this type where reversal of angle has been great, and we have succeeded in restoring the angle to a practical normality, we have added a few days, and it is usually about twelve to fourteen days before we discard entirely the posterior splint. By the twelfth or fourteenth day, these cases have only a leather wrist strap, with an ulnar cut-out for protection, and their final recovery is no less rapid than the others. From this time on, they use the hand for all ordinary purposes which are not accompanied by strain, but with care and common sense.

Reduce the displacement, begin motion early, and get away from all retentive apparatus as quickly as possible in these joint injuries, and we shall no longer have wrists which show a permanent disability following even the simplest of these compression fractures of the lower end of the radius. *E. Z. Holt, M.D., Atlantic City, N. J.*

THE TRANSOLECRANON APPROACH IN TRAUMATIC LESIONS OF THE ELBOW. H. Vulliet. *Presse Medicale*, December 9, 1922, p. 1065.

The paper concerns itself with fractures of the elbow in childhood, irreducible without operative interference. The writer's indications for this operation are (1) Fracture of the external condyle with the fragment displaced backward and turned roundabout, benefits by immediate operation. In most cases a small external incision suffices, but where this is insufficient, the joint should be opened by cutting through the olecranon. Without good replacement this fracture is apt to leave much deformity. (2) In transcondylar fractures near the epiphysis, it is generally possible to maintain good reduction without operation. In exceptional cases, however, with severe displacement laterally and posteriorly, an operation is necessary, and here the transolecranon approach is ideal. The operation itself is briefly described. A removable nail is used to fix the fragment. The olecranon is replaced by fine metallic suture. No drainage is used. Mobilization begins gently about the tenth day, and removal of the nail about the fourteenth day. Two illustrative cases are cited.—*J. A. Nutter, M.D., Montreal.*

DIAGNOSIS AND TREATMENT OF INCOMPLETE EPIPHYSEAL FRACTURES AT HIP. R. Whitman. *Annals of Surgery*, November, 1922.

The condition is usually confused in orthopaedic literature with a group of

static deformities under the title coxa vara.

Fractures of the neck of the femur during the developmental period may be divided into two distinct classes.

(1) Fracture of the neck proper and (2) fracture at the epiphyseal junction.

In childhood the fracture is practically always of the neck.

Epiphyseal fracture or slipping occurs, with rare exceptions, only in adolescents. It is generally incomplete and presents the characteristics of a progressive deformity rather than those of fracture. The exciting cause of displacement is apparently a superficial fracture at the superior portion of the junction. Gradual downward and backward displacement of the head upon the neck follows. Symptoms—Weight is borne on entire foot Persistent outward rotation of the limb which is increased by flexing the thigh. Actual shortening is present, but rarely exceeds one-half inch. Passive movements are restricted in flexion, abduction, and inward rotation, while extension—the movement first limited in disease—is actually increased in range. X-ray is distinctive—the elevation of the head is lessened and the outline of the head and neck may form an unbroken line on the upper border. The epiphysis is shallow—an indication of backward displacement. An actual separation may be present at the upper border.

The condition should be treated as a fracture. Under anesthesia, the pelvis having been fixed by abduction of the sound limb, the limb on the injured side is abducted to the degree permitted by the deformity. At this point the upper rim of the acetabulum, coming into contact with the neck, serves as a fulcrum and the head being fixed by the tense capsule, further abduction tends to force the extremity of the neck downward into proper relation with the head. This may be accomplished if the progression of deformity has been rapid, or in cases of secondary fracture it may be necessary to make two or three attempts before the restriction of range of motion is overcome. In cases in which the displacement is too great or the consolidation too advanced, open reduction will be necessary.

The joint is opened by an anterolateral incision exposing the neck, which in cases of advanced deformity conceals the head. From its extremity a thin section of bone is removed to permit the incision of the chisel between the two fragments, then, by rotation of the limb and leverage on the instrument, the head is replaced in normal position. The epiphyseal cartilage is always a part of the head fragment, so the removal of bone is of little consequence.

Limb is fixed by a long spica plaster in complete abduction and inward rotation for three months. Locomotion may be permitted in suitable cases.—*E. Z. Holt, M.D., Atlantic City, N. J.*

IMMEDIATE OPERATION AS METHOD OF CHOICE IN TREATMENT OF FRACTURE OF NECK OF FEMUR. A. O. Wilensky. *Annals of Surgery*, November, 1922.

Fractures of the neck of the femur are divided into those occurring at the base of the neck in proximity to or crossing the intertrochanteric line and those which occur partially or completely within the capsule. This paper deals with the latter group. The traction method of treatment is inefficient. Plaster of

Paris is more satisfactory. Conservative treatment is recommended in the old and the very young.

In considering cases of the second group—solid bony union occurs in only 10 to 15 per cent. of these cases. Difficulties and bad features encountered in treating fractures by abduction and fixation are many. Two case histories are used as illustrations. The pegging of the fracture with a living graft immediately after the injury is received is the method of choice in fracture of the neck of the femur in robust individuals. The technique of the operation is described in detail. The graft is so cut as to fit loosely in the drill hole extending into the neck and head of the femur. The cast is left undisturbed for two months. Patient is massaged and passive motion practised in bed for a month. Ambulatory splint is prepared and patient allowed to walk with the aid of the splint at end of the third month. Brace is discarded at end of six months.

Seven advantages of immediate operation are cited: (1) an accurate apposition of the fragments, and (2) their permanent retention in that position until the fragments are united; (3) the use of a living graft to encourage and aid the formation of sufficient callus; (4) a marked diminution in the time necessary for complete healing of the fracture; (5) the consequent economic saving; (6) the better anatomical result, including no loss of the neck angle, no shortening of the neck itself, no abnormal changes in the muscles, ligaments and soft parts generally; (7) the consequent better results obtained functionally. *E. Z. Holt, M.D., Atlantic City, N. J.*

NEOPLASMS.

VASCULAR TUMORS OF THE KNEE CAPSULE. Haas. *Deutsche Ztschr. f. Chir.*, August, 1922.

Author reviews the German literature, reporting nine cases of vascular tumors of the knee joint. He himself reports two cases he has observed. The first case, a man thirty years old, at operation, showed angiomatous masses of the knee joint synovia. These angiomatous masses were excised, but two years later, because of intolerable pain, effusions, and the handicap for labor, the knee joint was opened again. The angiomatous masses had multiplied greatly and had gnawed away the cartilage of the patella and the inner condyle of the femur and had penetrated into the metaphysis of the tibia. The knee joint was resected and the tibial infiltration was chiselled out. The second case was of a woman, 22 years old, with little red tumors the size of beans about the knee joint, and with complaint of great pain on climbing stairs and on kneeling, and with a limp in her gait because of the pain. At operation a tumor the size of a pigeon's egg was removed from the capsula fibrosa. Microscopic examination revealed an angioma surrounded by fat and connective tissue. In cases with intact bony frame, the author advises complete arthrectomy with extirpation of the primary angiomatous cavities, which are mostly in the capsula fibrosa. After-care consists of intensive baking, exercise, and hyperemia. The etiology of the tumor is the new formation and abundant vascular growth of the tumorlike proliferation of the blood vessels. Trauma plays an unim-

portant rôle. Bloody puncture on tapping the joint clinches the diagnosis as to tuberculosis and lues.—*Armin Klein, M.D., Boston.*

PERIOSTEAL SARCOMA IN ASSOCIATION WITH OSTEOMYELITIS. R. L. Rhodes. *Surg., Gyn. and Obstet.*, October, 1922.

Dr. Rhodes reports three cases in a very complete and concise manner. His summary given below cannot be bettered.

"1. The author reports three cases of large round-cell sarcoma, periosteal origin, associated with infection and necrosis of bone.

"2. All females, two white, one negro.

"3. Ages, 14, 12, and 20 years, respectively.

"4. Left tibia in each case.

"5. No history of trauma or serious illness.

"6. Local pain in two, none in the other.

"7. Staphylococcus aureus infection in each.

"8. Rapid pulse and rather high fever in two, none in the other.

"9. Treatment, mid-thigh amputations.

"10. Results, one dead, and two living free from signs of recurrence, local or elsewhere, to date.

"Case 1 developed in the hospital under our observation, and we feel reasonably sure, therefore, that the osteomyelitis preceded the sarcoma.

"Case 2. We questioned which preceded, although we did not suspect the infection and necrosis or abscess prior to operation, but found it upon dissection of the specimen. Might the history, however, of attacks of pain—"growing pains" for several months preceding the development of the tumor—suggest infection or abscess as the original?

"Case 3 gave an indefinite history, and showed a well advanced growth when we first saw her. The specimen was interesting in that there was a rather sharp line of demarcation at the site of the pathological fracture of the tibia—extensive osteomyelitis of the shaft above, whereas below there was widespread invasion by the sarcoma of bone and soft parts, extending downward even to the internal malleolus."—*H. A. Pingree, M.D., Portland, Me.*

DISEASES AND REGENERATION OF BONE.

BONE ATROPHY: A CLINICAL STUDY OF THE CHANGES IN BONE WHICH RESULT FROM NONUSE. Nathaniel Allison and Barney Brooks. *Arch. of Surgery*, November, 1922, p. 499.

The article is subdivided as follows: *I.* Introduction (1) Summary of previous study; (2) Object of present study. *II.* Material studied: (1) Adults; (2) Children. *III.* Relation between changes in bone as a result of lack of use and the cause of the nonuse. *IV.* Character of changes in adults. *V.* Character of changes during period of growth. *VI.* Effect of nonuse on growth of bone. *VII.* Effect of nonuse on regeneration of bone. *VIII.* Recovery from bony atrophy. *IX.* Summary.

Clinical cases of nonuse due to the following causes are reported: (1) poliomyelitis; (2) spastic paralysis; (3) peripheral nerve injuries; (4) Friedreich's ataxia; (5) pseudo muscular atrophy; (6) syringomyelia; (7) chronic infectious arthritis; (8) tuberculosis of bone; (9) acute pyogenic osteomyelitis; (10) ischaemic contracture; (11) fracture; (12) congenital deformities, and (13) astasia abasia.

Sixteen cases are reported with excellent radiograms and careful measurements showing the changes which take place. In adults the process of bone atrophy alone operates. During the period of growth, bone atrophy is associated with inhibition, but not the arrest of growth by nonuse. Bone atrophy does not affect the process of bone regeneration. Even after prolonged periods of nonuse and marked bone atrophy, upon resumption of active use the bones recover from the atrophy and develop considerably, although in unilateral cases they do not return to absolutely normal or catch up with the actively used limb. Even after prolonged confinement in bed the bones show marked atrophy. This is a most interesting article, carefully prepared, and logical in its conclusion. It is a continuation and a corroboration of the excellent experimental work previously presented by the same authors.—*F. G. Hodgson, M.D., Atlanta.*

BONE REPAIR FOLLOWING INJURY AND INFECTION. F. W. Bancroft. *Arch. of Surgery*, November, 1922.

After discussing the various theories of osteogenesis, the author states that an acceptable theory should be broad enough to explain the irregular types of bone formation as well as the repair which follows fractures and infections. He thinks the subject has been made too complex: we have been lost in the by-ways of periosteum, endosteum, and bone reticulum. It is much simpler to believe that bone occurs as a chemical deposition in connective tissue, a theory explaining bone formation as it appears in all parts of the body.

Believing that bone grafts serve only as a framework for new bone, and stimulate osteogenesis, we should, therefore, apply grafts that can easily have a blood supply established.

In fractures, an effort should be made to increase the blood supply; therefore, early motion is advised. The problem is that of producing the right chemical state in the tissues.

In osteomyelitis, especially in children, conservative surgery is advised. Early drainage, with as little trauma as possible, and Carrel Dakin treatment, avoiding hasty, extensive removal of bone, will often save bone which may appear dead.—*R. W. Billington, M.D., Nashville.*

OSTEOSCLEROSIS FRAGILIS GENERALISATA. George G. Davis. *Arch. of Surgery*, November, 1922.

This is a detailed report of a case, with review of literature and similar reported cases, of Albers-Schönberg disease. The patient was a boy, aged eleven years, who had had several fractures of long bones, each due to mild trauma.

He was essentially normal except for a recent fracture of the right tibia, and the characteristic x-ray findings throughout the whole skeleton, consisting of a generalized disturbance of the bony structure, characterized by a marked, irregularly increased density of certain portions, with thinning and rarefaction in other areas. In the long bones, the tendency was toward a marked narrowing of the medullary canals in the middle third, due to thickening of the cortex, with the ends of the shaft presenting an expanded appearance, with thinning of the cortex and a coarsely mottled effect due to increased density in the marrow cavity. The epiphyses and small bones, as vertebrae, carpals and tarsals, presented generally increased marble-like density, with absence of bone structure. Epiphyseal lines were all present, but had slightly irregular margins. The same increased density was found in the mastoids, and at the base of the middle and anterior fossae of the skull, but the vault appeared normal. The fossa for the pituitary gland was 8 mm. in diameter.

The condition is considered a separate entity from fragilitas ossium.—*R. W. Billington, M.D., Nashville.*

CHANGES IN THE MORPHOLOGY AND FUNCTION OF THE BONE MARROW AFTER SPLENECTOMY. Ernest M. Johnstone. *Arch. of Surgery*, July, 1922.

The object of this research was to determine the behavior of the bone marrow after splenectomy, by observation of repeated specimens taken at regular intervals over a sufficient length of time, and adequately controlled.

Previous observers report negative findings for the first six months, but definite changes after six months. The most severe anemia, however, and the largest number of recoveries therefrom occur during the first six months.

Control was obtained by checking against specimens taken before splenectomy, and against specimens taken from non-splenectomized animals subjected to the same conditions as the splenectomized animals.

Maximal changes were noted during the fourth and fifth months, a period during which the previous investigators had made no observations. Rib marrow was selected for observation, since it shows changes earlier than femur marrow. Ten factors were considered, *viz.:*

In the marrow itself: erethrogenesis, leukogenesis, vascularity, and density of marrow cells.

In the blood: haemoglobin content, red cell count, white cell count, and differential study.

In regard to the animal in general: weight and general condition.

The observations were continued during a period of fifty-four weeks.

Comparison of the marrow of one animal with that of another is not safe, since marrow differs greatly in activity in different animals. There was also found a very marked difference in the activity of the marrow in several specimens taken at different times from the same control animals. Haemopoiesis seems to be somewhat periodic, and to have seasonal and other variations.

Marrow increases its capacity by replacement of fat cells with marrow cells, and by enlargement of the marrow cavity by thinning of the bone cortex and septi. The character of the marrow cells changes as activity increases, myeloblasts and myelocytes being replaced by megaloblasts and normoblasts.

After splenectomy, there is a latent period of about four weeks, then increased erethrogenesis, reaching its maximum after eight to twelve weeks, and continuing at this height about twelve weeks; thereafter decreasing gradually, though its activity remains above normal for a year or more. No reduction in the anemia is evident until the increased erethrogenesis has been in evidence four weeks or more. The marrow generates only a few lymphocytes.

The author's conclusions are that removal of the spleen from a healthy animal is followed by hyperplasia and hyperactivity of the marrow, beginning soon after splenectomy, and continuing for more than a year. This is probably the result of the anemia which follows the removal of the spleen. This increased activity is exactly paralleled by increase in cell and haemoglobin content in the blood stream.—*C. L. Lowman, M.D., Los Angeles.*

OSTEOMALACIA. E. P. C. White. *Arch. of Int. Med.*, November, 1922.

Osteomalacia is a generalized softening of adult bones. The following types are recognized: 1. Mild form. Pregnant, puerperal, and lactating women. 2. Severe type occurs in old people. Bone softening as a rule is confined to spine and pelvis. 3. A severe form occurs in pregnant and puerperal women. Microscopically and chemically there is absorption of calcareous salts.

The various theories are advanced: 1. Caused by hyperfunction of internal secretion of ovaries. 2. Decrease of alkalinity of the blood, which permits bone salts to go into solution. 3. Food poor in calcium. The destruction of the calcium and phosphorus metabolism may be due primarily to (1) the removal of alkaline salts from the diet (famine osteomalacia); (2) drain from the alkaline storage of the body associated with a deficient diet, as in cases of osteomalacia of pregnancy and lactation; (3) in the combined action of a diet faulty in more than the salt content, which by production of acid in its oxidation and by favoring the development of acid growing bacteria causes a drain of the body alkali for the neutralization of this acid.

In the severe cases of osteomalacia the power to absorb calcium and phosphorus is practically lost, while in the cases developing during famine and in pregnancy and lactation, this power is retained. All factors enumerated do tax the metabolic resources of the body and depress the function of the endocrine glands. The starting point of treatment must be a diet adequate in vitamins, and containing a proper inorganic balance.—*Voigt Mooney, M.D., Pittsburgh, Pa.*

OPERATIVE PROCEDURES.

CASES OF ARTHROPLASTY OF ELBOW: INTERPOSED FLAP OPERATION. W. C. Campbell. *Annals of Surgery*, November, 1922.

Arthroplasty of the elbow should be performed only in selected cases. The following pathological conditions decrease the chances of success or actually contraindicate surgical measures.

1. Tuberculosis—in no case should a joint be entered for the purpose of mobilization when tuberculosis has been the causative agent in the production of ankylosis.

2. Destructive osteitis in early life which has obliterated the epiphyses—a materially shortened extremity is encountered.

3. Extensive scar tissue binding the skin to the bone.

4. Extreme muscular atrophy with reorganization of bone structure, as is seen when a bony ankylosis has existed for a long time, making one canal from the shoulder to the wrist.

5. Old, dense, eburnated bone when found for a considerable distance on both sides of the joint.

The two conditions in which open surgical procedures should be employed in ankylosed joints are:

1. Traumatism, causing a crushing of joint surface, tearing of periosteum, or multiple fractures, followed by bony ankylosis.

2. Acute infectious arthritis due to staphylococcus, streptococcus, gonococcus, pneumococcus, etc.

Five well-known methods of operation are outlined:

1. Wide excision of articular surfaces, which should not be considered.

2. Pedunculated fascial flaps between the articular surfaces after carving out a new joint. This method has been discarded by most operators.

3. Interposition of animal membranes.

4. Transplantation of free fascia lata.

5. Mechanical reconstruction of the articular surfaces without the interposition of any substance.

The author is now using the following method:

An incision is made six to eight inches long on the posterior aspect of the arm and forearm just external to the midline, beginning above, about the middle of the humerus, and ending below, about two or three inches below the elbow joint. Skin, superficial and deep fascia are incised and the deep fascia dissected laterally about one inch. The broad aponeurosis of the triceps is dissected from above downward, making a long tongue attached to the tip of the olecranon below. A further incision in the midline passes through the muscular fibers of the triceps and periosteum to the humerus over the lower half. A periosteal elevator is used to strip the periosteum from the lower end of the humerus. Scar tissue, callus, and loose bony particles are removed. If dislocation exists, reduction is accomplished. About one-half to one inch is removed from the lower end of the humerus, which is remodeled into a surface convex from before backward, no attempt being made to reproduce trochlea or capitellum. About one-half inch bone is removed from tip of olecranon. All scar tissue is dissected from the sigmoid cavity. The surface is not disturbed but the surface of the head of the radius must be made the same level as the coronoid process. A rasp and file render all surfaces smooth. The periosteum and triceps muscle are dissected into a double flap which is stitched to the anterior capsule, thus separating the raw bony surfaces by a living mass of tissue with abundant blood supply and no risk of pressure necrosis. The capsule of the joint is stitched to the posterior aspect of the triceps muscle and deep fascia, thus closing off the new joint. The wound is then closed in layers.

The after-treatment is important. Active motion is most essential.

The method is illustrated by details of two cases.—*E. Z. Holt, M.D., Atlantic City, N. J.*

PATHOGENESIS AND TREATMENT OF DEFORMITIES OF THE GREAT TOE. Second Question Discussed at the Fourth Congress of the French Orthopaedic Society. Albert Mouchet. *Presse Médicale*, October 14, 1922.

1. Hallux valgus is seen especially in the adult, and a little more often in women. It is generally bilateral and often seen with flat feet. It is congenital more often than it is supposed to be. Young explained this by the intermetatarsal bone, a supernumerary bone between the internal cuneiform and the first and second metatarsals. This is probably exceptional. The mechanical action of improper footwear is undeniable, but Kirmisson holds that the first place in the list of causes should be given to arthritis of various kinds. Well-fitting shoes should cure most cases of hallux valgus. They should be long enough and broad enough. In young subjects forcible correction followed by immobilization will cure. If a proper shoe fails to relieve, one must operate. In elderly persons palliative measures are best. Tendon operations will not cure and amputation of the great toe is not recommended, except possibly in elderly persons.

Schede extirpates the painful bursa and resects the exostosis, a plan which is of service only in mild cases.

Reverdin's operation consists in carrying out Schede's procedure and then removing a wedge of bone from the metatarsal head, the base to the inner side, allowing correction. This operation is popular. The resection of the metatarsal head (Hueter) is an excellent and popular operation.

Edmond Rose and Lovett resect the metatarsophalangeal articulation and extirpate the sesamoids.

Manclaire (Paris) does oblique resections of the head of the metatarsal and of the base of the phalanx. Postoperative care is of the highest importance.

1. Hallux varus is either acquired, which is rare, or congenital, which is seen more frequently as a supernumerary toe. The treatment is surgical, may be amputation.

Mr. André Trèves (Paris) described an operation where the cartilage on the metatarsal head was kept and placed against the raw bone left by resection. He transplanted the long extensor to the inner side, after lengthening it if necessary.

Dr. Tixier of Lyons, Dr. Paul Hallopeau of Paris, Dr. Lance of Paris, and Dr. Rocher of Bordeaux all favored simple resection of the head of the first metatarsal. *J. A. Nutter, M.D., Montreal.*

A NEW APPROACH TO THE SEMILUNAR CARTILAGES. Percy Willard Roberts. *Jour. Amer. Med. Assn.*, November 4, 1922, p. 1608.

The author feels that the period of convalescence following operation for excision of the semilunar cartilages of the knee can be shortened by early mobilization of the joint. He reports eight patients operated on by the following technic, and supplies two excellent diagrams.

The purpose of the operative approach is to place the wound so that no

strain will come on it when the knee is bent. A blunt V-shaped incision is used, one arm which starts about three-eighths inch above the upper border of the tibial condyle and follows down the border of the patellar ligament for one and one-half inches; then carried transversely, then up inside of the lateral ligament to the level of the upper end of the opposite arm; cut carried down through all the tissues, including periosteum. Flap then raised and retracted upward; coronary ligament incised transversely, retraction continued until the lower surface of the meniscus appears on the under surface of the flap. Cartilage removed, wound closed by uninterrupted chromic gut sutures; synovial membrane not sewed. Skin closed with silk. Patient urged to move joint as soon as he comes out of ether and repeat every two hours; passive motion prohibited.—*Edward S. Hatch, M.D., New Orleans.*

MISCELLANEOUS.

Pathologic Changes in Muscle as a Result of Disturbances of Circulation. An Experimental Study of Volkmann's Ischemic Paralysis. Barney Brooks. *Arch. of Surgery,* July, 1922.

After a review of the more important researches on the subject, the author describes his own experiments, which consisted in interference with the circulation or the innervation or both circulation and innervation of the muscles of the extremities of dogs in the following ways:

1. By constriction with tourniquets, splints, and plaster bandages, kept on from five to 24 hours.

The conclusions from these experiments were that such constriction affected both innervation and circulation, that the degree of interference could not be controlled, and that the results were not uniform.

2. By permanent obstruction of the primary arteries of an extremity by ligation.

The results were:

(a) A coldness, stiffness, and easy fatigability of the muscles, entirely recovered from with establishment of collateral circulation.

(b) The above, coupled with more extensive changes, *viz.*, a sharply localized necrosis of skin, and sometimes of tendons, and degeneration of portions of muscles—the rest of the musculature regaining later its entire function.

(c) Total paralysis and necrosis of some muscles and total non-paralysis and viability of others, with one exception, which showed a single muscle in part paralyzed and necrotic and in part non-paralyzed and viable.

These degrees of change corresponded with the extent to which collateral vessels were ligated. The condition produced corresponds to the well-known clinical condition to which the term ischemia is applied, and which seems to be a fatigue phenomenon.

Two points are emphasized concerning these experiments:

(a) That where the anatomic integrity of a muscle was unimpaired its physiologic function always remained intact.

(b) Necrosis of skin was always produced earlier and to greater extent than necrosis of muscle, and in several instances without accompanying necrosis of muscle.

3. By temporary obstruction of the primary arteries of an extremity by application of clamps, later to be removed. The clamps were left on for different lengths of time, from six to 24 hours.

In these experiments the most extensive changes were not in the skin, but in the muscles. In all there was coldness of the extremity and paralysis of muscles while the clamps were on. On removal after six hours there was complete return of function. In some of those animals where clamps were left on for 17 hours or longer, there followed extensive necrosis of muscles even though good pulsation returned in all the larger arteries of the extremity. This necrosis was preceded by inflammatory reaction.

In one experiment where clamps were left on for 17 hours the return of pulsation in the arteries was very feeble, and in this case there was no inflammatory reaction or swelling, and on exposure of the muscles before death of the animal, they showed mottling with pink areas which responded to electrical stimulation, and yellow areas which failed to respond.

4. Experiments on isolated muscles: The rectus femoris muscle having been freed completely except for its tendinous origin and insertion, and its connection with artery, vein, and nerve, a tight ligature was tied around each end of the muscle to isolate it completely from all other vascular connection.

(a) The nerve was divided, leaving artery and vein intact. The result was primary atrophy rather than degeneration.

(b) Ten c.c. of blood aspirated from the femoral vein was injected into the muscle, distending it with blood. Examination after one month showed no abnormality, either physiologic or anatomic.

(c) Ligature of the artery, leaving the vein intact. Examination at some seven to 60 days, postoperative, showed normal physiologic properties, adhesion of the muscle to the surrounding tissues, and slight degenerative changes in some instances.

(d) Section of artery and nerve. Examination after 60 days showed the typical atrophy of nerve paralysis.

(e) Ligation of the artery with diminution of the blood supply to the entire extremity by other ligations: The result was either no change in the muscle, or complete absence of the muscle in seven to 12 days if the circulation of the extremity was extensively blocked. The muscles either retained wholly their physiologic and anatomic characters or became wholly necrotic and disappeared.

(f) Ligation of the veins alone: Examination at the end of one to 120 days showed marked pathologic changes in every instance. The muscle becomes swollen, hard, dark blue, and paralyzed; and then follow great extravasation of blood into the muscle, accumulation of polymorphonuclear leucocytes, and necrosis of many muscle fibers; then marked connective tissue proliferation and degeneration of muscle fibers, proceeding to a fibrosis, in the midst of which are usually some muscle fibers which preserve slight contractility but which may be so extensive as to crowd out all muscle fibers. The fibrosed muscle then invariably became contractured.

The results in this occlusion of the vein from a muscle isolated from the surrounding tissues were always the same, *viz.*, an inflammatory stage followed by an extensive fibrosis.

The author reasons that the primary cause of this is probably mechanical—raising the blood pressure high enough to destroy the capillary system, thereby interfering sufficiently with the nutrition of the tissues to produce degeneration or necrosis, accompanied by an inflammatory reaction. Marked obstruction to return of blood from tissues to which the arterial flow is not obstructed produces inflammatory rather than degenerative changes. Degeneration is present but does not involve all the tissues of the muscle and is overshadowed by the inflammation and subsequent proliferation of connective tissue. This proliferation continues for several weeks and the end-result is the conversion of the muscle into a mass of fibrous tissue.

The author concludes that the classic picture of Volkmann's ischemic paralysis can be explained only on the basis of an acute venous obstruction.—*C. L. Lowman, M.D., Los Angeles.*

Case of Myositis Ossificans Progressiva in a Child. J. A. Henderson. *Edinburgh Med. Jour.*, September, 1922.

In this child, a female, the mother first noticed evidence of the disease when the child was two weeks old in the appearance of a swelling in the left sternomastoid muscle, which developed a torticollis and became bony in part. Following this were other swellings on the head, the back of the neck, the anterior bellies of the digastric muscles, and in the pectoral muscles. It was early observed that the great toes were short. Henderson summarizes the characteristics of this disease as follows:

1. The disease is characterized by periods of quiescence, alternating with "acute phases," during which the slightest trauma produces the swelling described.

2. The disease is present at birth, but does not manifest itself until the acute phase is present.

3. The swellings themselves are apparently of the nature of an acute myositis, with subsequent increase of connective tissue and fibrous transformation of the muscle. Bone may form or the swelling may disappear.

4. Characteristic deformity of great toes and sometimes of thumbs is present from birth.

5. The muscles chiefly affected are those of the scalp, neck, trunk, limbs, and masseters, leaving unaffected hands, feet, muscles of expression, external eye muscles, muscles of pelvis and genital organs, the sphincters, and all unstriped muscles. No treatment is effective.

6. No rise of temperature has been noted in the case.—*C. A. Parker, M.D., Chicago.*

On the Etiology of Perthes' Disease. N. Rehbein. *Deutsche Ztschr. f. Chir.*, 1922, September, 1922.

Dolle could assemble only thirty-eight cases from the world's literature of traumatic dislocation of the hip in childhood. Author saw a case of Perthes' disease, which, by its development on the basis of a traumatic luxation, is especially interesting. The case is of an eight-year-old child who fell on the ice, and when seen the same day showed by x-ray a dislocated hip. After re-

duction and convalescence the patient was discharged with an apparently normal hip. Patient returned a year later with a painful knee on the affected side and a limp. On x-ray examination Perthes' disease of the hip was disclosed. Trauma as a cause of Perthes' disease has been discounted by Brandes on the basis that the injury was usually too slight, and congenital disturbances of development have been made the disposing factors. Author feels that Brandes has gone too far in his leaning away from trauma, and points to the case just cited as proving that trauma alone can produce Perthes' disease in a thoroughly normal head of the femur. He believes the reduction, because of the ease with which it was accomplished, was not a factor here in producing the Perthes' disease. The mechanics of the injury also answers for an injury of the ligamentum teres, therefore explaining a secondary deforming process following a vascular injury.—*Armin Klein, M.D., Boston.*

SPRAINS OF RHOMBOIDEUS MINOR MUSCLE: STUDY OF ONE HUNDRED AND FIFTY INJURIES OF SHOULDER GIRDLE. J. P. Replogle. *Annals of Surgery*, November, 1922.

A diagnosis of "sprain of the shoulder" is too frequently made without attempting to make a more definite diagnosis. The term sprain is too evasive. In an analysis of 150 successive cases of shoulder injuries observed at the Cambria Steel Company Hospital, 26 varieties of lesions were noted. Contusions, 30 per cent.; sprains of various muscle groups or individual muscles, 25 per cent.; dislocations and fractures, 18 per cent.; subacromial bursitis, six per cent. Sprain of the rhomboideus muscle is more frequent than any other traumatic lesion of the shoulder, excluding severe contusions. The sprain occurs during the performance of heavy labor—swinging a sledge, firing a furnace, etc. A sudden knife-like, stabbing pain just median to the base of the spine of the scapula occurs. Pain lasts for a quarter of an hour, returns in the evening and occurs on motion, subsequently. A very definite localized point of tenderness about the size of a quarter is noted just internal to the base of the spine of the scapula. The arm cannot be abducted beyond 90 degrees without the production of pain.

In treating these cases the shoulders are thrown back and are maintained in this position by criss-cross adhesive straps. The arm is placed in a sling and a pad placed under the adhesive, over the point of tenderness, to possibly hasten the absorption of the serous effusion at the point of rupture.

The treatment, therefore, is simple and is efficacious.—*E. Z. Holt, M.D., Atlantic City, N. J.*

NEUROPATHIC ARTHROPATHIES: CHARCOT'S SPINE. John Ridlon and E. J. Berkheiser. *Jour. Amer. Med. Assn.*, October 28, 1922, p. 1467.

Ten cases are reported and a number of skiagraphs shown. The symptoms, complications, prognosis, and treatment are taken up and the differential diagnosis from tuberculosis, hypertrophic arthritis, malignant disease, compression fracture, typhoid spine, and Paget's disease is very carefully gone into.

This condition occurs most often in males and in any region of the spine; bony changes are destruction, proliferation, and displacement, usually laterally. Treatment: Plaster or leather jackets with active anti-syphilitic medication.—*Edward S. Hatch, M.D., New Orleans.*

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The Journal of Bone & Joint Surgery

PRESIDENTIAL ADDRESS

Delivered before the American Orthopedic Association, Rochester, N. Y., June 7, 1923

BY RALPH R. FITCH, M.D., ROCHESTER, N. Y.

When the American Orthopedic Association elects a man to be its President, it confers much honor upon that man. Permit me to extend to you my most sincere thanks for your unwarranted generosity in making me your President, and also permit me to assure you that I am not unmindful of the responsibilities that go hand in hand with the honor which you have bestowed upon me.

The President is required to prepare an address to be delivered before the Association. The term "address" brings to us all memories of many lengthy dissertations which have been delivered by masterful orators who have held us spellbound by their powers. I must content myself by presenting to you two thoughts which have been much in my mind—thoughts which I shall attempt to convey to you in a very few words. The brevity of my remarks will conserve the time of the Association and will, I trust, prevent befogging by needless words the points which I wish to make.

During the childhood years of the Association, the membership was small—every member knew every other member intimately and the annual meetings simulated, to a large degree, family gatherings. The President, with the able assistance of the Secretary, conducted most of

the affairs of the Association. What the President thought and said, or rather, what he was told by the Secretary to say, usually was accepted as law. To be sure, there was an Executive Committee, but even the duties of this honorable body were largely carried on the broad shoulders, and by the infinite zeal, of the Secretary.

As time has gone on, great changes have occurred in the make up of the Association and in the manner of conducting its affairs—changes that have been brought about by the expanding scope of Orthopædic Surgery, by the expanding geographical area whence come our members, and by the ever and rapidly increasing number of physicians who are interested in our special work.

Early in the history of the Association, it was deemed wise to have an Editorial Committee and a Membership Committee. At first the duties of these committees were not difficult. Those of the former were completed with the publication of the Transactions of the Association; those of the latter required but little time or thought, as the number of applications for membership was small and the qualifications of each applicant were well known through personal observation.

After the virgin growth of timber had been exhausted in the presidential chair factory, a Nominating Committee was authorized by the Association and thus ended the good old days. No more shall presidential plums be promised two and three years in advance!

With the expanding boundaries of Orthopædic Surgery came new problems in the preparation of the programme for the annual meeting. Formerly, practically all of the subjects pertaining to Orthopædic Surgery could be found on the programme of a single meeting; this is now impossible owing to the manifold ramifications of the specialty. We now have a Programme Committee whose duty it is to prepare a well balanced programme for each meeting and to see that every subject germane to Orthopædic Surgery is allotted an appropriate amount of attention over a period of years.

An increased number of applications for membership coming from all parts of this country and Canada added greatly to the responsibilities of the Membership Committee. It became more and more difficult to do justice to the Association and to applicants. The obtaining of credentials and the presentation of a thesis by applicants proved to be an inadequate method of judging the desirability of admitting applicants to membership. The present system of having each applicant pass a probationary period of three years safeguards, to a greater extent, the interests of the Association.

In spite of all precautions that can be taken an undesirable applicant

will, from time to time, be admitted to membership in the Association. We have been working for years to build up an Association for the advancement of Orthopaedic Surgery. We have largely perfected its organization and have safeguarded the portal of entry to membership. What I wish to propose is some method of cleaning house from within, whenever a house-cleaning is desirable. A single blot on a sheet of writing paper brings up visions of the scrap basket. An irresponsible member in an association is the keynote of discord. Why should the American Orthopedic Association permit its membership roll to be blurred by the name of any man who is unworthy of its best traditions? It is time that the American Orthopedic Association issued a proclamation of independence to the effect that, when a member becomes persona non grata to the majority of other members, he shall forfeit his membership in the Association. The safeguarding of the membership of the Association is a subject that is very dear to my heart. I beg of you to cherish the goal of an ideal membership.

The second thought that I wish to present to you pertains to medical literature.

At a meeting of the Association of American Medical Editors which was held in New Orleans in 1920, a number of papers were presented on the subject of the debt of the medical profession to current medical literature. In this series of papers, the great value to the profession of good medical publications was clearly demonstrated and the obligation of the profession to medical writers and editors was pointed out. The scope and methods of presentation of American medical literature were compared to those of other countries and suggestions were made as to the possible need of other types of medical publications in America.

I venture to add a suggestion which, if carried out, would, I think, help to make current medical literature of still greater value. Medical articles are written presumably for the purpose of permitting the profession to profit by the observations of the writers. It not uncommonly happens that writers change their opinions and modify or entirely discard the procedures which they have perhaps but recently set forth in print. How seldom are these changed opinions published! Would it not be a good plan for medical writers to consider it a moral obligation to keep the readers of their articles posted as to their changing or changed opinions? Would it not be wise for medical editors to inquire from contributors to their publications whether or not, after the lapse of a certain time, they still maintain the opinions which they have expressed in their published articles? By so doing, information which is the basis of knowledge could be obtained.

LOOSE BODIES IN JOINTS AND BURSAE DUE TO SYNOVIAL OSTEOCHONDROMATOSIS.*

BY MELVIN S. HENDERSON, M.D., AND HUGH T. JONES, M.D.

Section on Orthopaedic Surgery, Mayo Clinic, Rochester, Minnesota.

Loose bodies of intrinsic origin found in joints may be classified in two groups, those composed of unorganized tissue, the outstanding example being the rice bodies or corpora oryzoidea, not infrequently seen in cases of tuberculosis, and those composed of organized tissue, cartilage, fibrocartilage, or bone, seen in cases of osteo-arthritis, osteochondritis dissecans, and osteochondromatosis.

Osteochondromatosis is a rare condition found in various joints and sometimes in the bursae near the joints. The synovial membrane becomes the site for the formation of osteocartilaginous bodies, often great in number, consisting of cartilage, or bone, or both. The condition is a benign neoplasm. No record can be found in the literature or in our own cases of metastasis in any true case of osteochondromatosis, although a local recurrence is not uncommon following removal of the bodies. The condition is distinct from osteochondritis dissecans and osteo-arthritis, in which loose bodies are formed. In osteochondritis dissecans, which rarely occurs in any joint except the knee, the bodies arise from the articular cartilage, usually the internal condyle, and in osteo-arthritis they originate in the marginal osteophytic growths.

REVIEW OF LITERATURE.

In a careful review of the literature we have found reports of twenty-five cases which seem to be osteochondromatosis. This condition has not been well catalogued, and it has been necessary to cull many of the cases from those indexed merely as loose bodies. Besides the twenty-five cases, numerous references have been made by various authors to cases which they have observed, but of which complete reports are lacking. Various terms have been used to describe the condition, such as diffuse

*Read before the New York Academy of Medicine, New York City, February 16, 1923.

enchondroma of the cavity of the joint, chondromatosis and chondroma of the capsule of the joint, chondromas of the synovia, and osteochondromatosis. Three of the twenty-five cases were reported by one of us (16, 17, 18, 19) in 1916, 1917, and 1918, respectively. Since then we have observed twelve cases, making a total of fifteen observed in the Clinic. We are also reporting three cases which we believe to be osteochondromatosis, but in which definite proof is lacking.

Since 1558, when Ambrose Paré incised a knee-joint and released a loose cartilage, various observers have manifested an exceptional interest in these bodies in the joints. Credit has been given to Laennec, who, in 1813, gave the first description of the formation of bodies in the joints by the process under discussion. Laennec believed that the bodies originated in the subsynovial tissues. Rokitansky held the opinion that the "fibrocartilaginous concretions" developed in the subserous cellular tissue, or in the serous tissue itself. Sir B. Brodie asserted that the bodies usually had their origin in the synovial membrane, but he described certain specimens of which the site of origin seemed to be outside this membrane. Both Rainey and Kölliker gave descriptions of the gross and microscopic appearance that are hard to improve on, even at the present time. Virchow described a case which was probably a manifestation of what we now call osteochondromatosis. Since then various writers have described the condition. (1, 6, 10, 14, 20, 23, 35).

A review of the subject was published in 1902 by Joseph Bryant. Marsh, Bland-Sutton, Berry and Fisher have reported the removal of 1047 bodies from a knee-joint, and all apparently refer to the same case. There was, according to the reports, nothing abnormal in the synovial membrane, so whether or not this case is true osteochondromatosis can only be surmised. The large number of bodies certainly suggests osteochondromatosis. Carothers, in 1914, reported a case which was exceptional in that both knee-joints were involved. One of us (16, 17, 18, 19) in 1916, recorded the condition in a knee-joint, in 1917 in a knee-joint, and in 1918 in an elbow. Fisher has reported three cases, one of the three being Marsh's, and in discussing the etiology said that it was closely related to the etiology of tumors. Lamson's discussion of the subject included a report of a case in which six bodies were removed from the knee-joint. Strange to say, the bodies apparently originated in the tibia.

In the early part of this century, renewed interest in the subject was shown by German writers. Reichel, in 1900, gave an excellent report of a case of multiple loose bodies in a knee-joint. He was at a loss to

account for their presence and suggested an agent of contagion, although he was unable to find an inflammatory process. Whether he meant that he believed the cause to be infection, as we ordinarily understand the term, is open to doubt. Contemporary authors on the subject have, however, credited him with the theory of infection. Reichel attributed to Müller a report at a surgical meeting of a case of loose bodies in a metacarpophalangeal joint, but Müller did not give a complete report in the literature until 1902. Riedel, in 1903, reported finding the bodies in a wrist-joint. Certain of the carpal joints were affected on the ulnar side. Simple arthrotomy had been performed, and Riedel extirpated the capsule; there was a recurrence within one year. Langemak, in 1904, recorded the involvement of the astragaloscaphoid joint. Hagemann later questioned Langemak's statement that the anterior epiphysis of the astragalus is the site of origin, arguing that the tarsal bones do not have epiphyses. Hagemann believed that the bodies originated in the joint. He accepted Langemak's case, however, as one of osteochondromatosis. Lexer, in 1907, mentioned finding the bodies in a knee-joint; the suprapatellar pouch had broken and the bodies were in the muscle. He must have feared recurrence, for he removed 11 cm. of the lower end of the femur and 5 cm. of the upper end of the tibia, and inserted a piece of ulna removed from a cadaver. The wound suppurated for five months, but, on removal of the graft, ankylosis soon occurred. Lexer suggested the hypothesis that since the component parts of the joint are all developed from the same layer of the axial blastema, the condition is due to a faulty mesenchymal differentiation in the formative process of the joint. Lichtenberg, in 1907, recorded the case of a knee-joint in which he had performed a synovectomy with good results. Kobylinski, in 1909, resected a knee-joint for osteochondromatosis. Rehn, in 1911, reported a case of bodies in the left elbow. Bibergeil, in 1913, reported the condition in the carpal joints. Hagemann, in 1913, reported that he had resected a shoulder, removing the head of the humerus, the capsule, and the rim and surface of the glenoid fossa. He believed that the bodies originated from the synovial membrane; they were most numerous in the folds and pockets where the membrane was reflected from the bone. This case he considered unusual in that the formations encroached on the cartilage of the head of the humerus. He explained this by calling attention to the fact that at the fourth month in fetal life the margin of the articular surface of the bone is covered by a cellular and vascular tissue which is a prolongation of synovial membrane. Hence he considered that the changes on the articular surface really came from synovia and not from cartilage.

In his case the two bursae close to the shoulder each contained a loose osteocartilaginous mass, and the lining was clearly the site of its formation. In the only shoulder from which we removed multiple loose bodies we could not definitely prove that the condition was, or was not, due to osteochondromatosis (Case 9). In the roentgenogram, evidence of osteo-arthritis was seen at the margins of the joint. We removed the bodies through such a small incision that no inspection of the synovial membrane was possible, but from the roentgenogram and from the gross and microscopic appearance of the bodies we are convinced that it is a case of osteochondromatosis and have so classified it. Eden, in 1914, resected the head of the left femur, removing many loose bodies and, after moving the trochanter down lower on the shaft of the femur, implanted the upper end of the femur into the acetabulum. Kobylinski's report of a case of the condition in an elbow-joint appeared in the German literature in 1914. In the same year, Troell, of Stockholm, described a case in which the knee-joint was affected. Kopp, in 1916, placed on record three cases, two of which appear definitely to be osteochondromatosis. His examination in one case convinced him that the bodies start as osteomas, because he did not find cartilage around the smaller bodies. Kienbock, in 1917, reported formations in two knees, one elbow, and one ankle, calling them chondromas of the capsule of the joint. The conditions which he described do not correspond with our understanding of osteochondromatosis, but they may represent, as he claimed, a more advanced development of the same process, and undoubtedly are closely related to it. In 1920, Lotsch reported two cases involving the knee-joint, and in 1921, Ziegner presented a case in which the elbow-joint was involved.

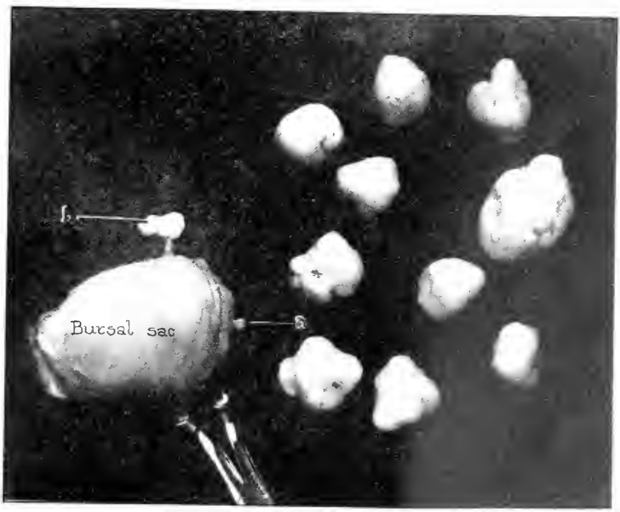
ETIOLOGY AND PATHOLOGY.

There seems to be no direct evidence that infection plays a part in the development of this interesting condition. Heredity, so far as the literature or our own experience proves, is a negligible factor. Certain authors have suggested that osteo-arthritis is related, in some manner, with osteochondromatosis. It is true that there is occasionally a marginal lipping, but this probably is a secondary finding. Trauma, recent and old, deserves consideration; in exactly one-half of our cases there were histories of severe trauma sustained years before. The condition in the knee reported by one of us ([17]) in 1917 seemed to have a definite relation

to severe trauma, as the symptoms of locking followed soon after the subsidence of the effusion which persisted for six months. Many who have written on the subject mention trauma as a factor. In further support of this theory it may be said that fifteen of our eighteen patients were men. The fact that the majority were between twenty and forty years of age, in the active period of life, is also significant. In the cases collected from literature the sex was more evenly divided. While we may acknowledge that trauma is a factor, it cannot be more than contributory.

When we consider this unusual condition from the viewpoint of etiology we find ourselves in the same maze that is encountered in studying the etiology of tumors. We believe, however, that we are dealing with a benign neoplasm. Our one case in which osteochondromatosis was definitely present in the knee-joint and a chondroma invaded the lower epiphysis of the femur is very suggestive. Although malignancy could not be determined by exploratory operation, the tumor in the femur soon revealed signs of greater activity, and amputation was performed. A rapidly growing chondrosarcoma was found in the lower end of the femur, but malignancy was not found in the joint itself. The patient died in cachexia with multiple metastatic growths in the lungs. Possibly if the trauma is very severe, cells are squeezed into the synovial fluid of the joint and, being nourished by it, multiply sufficiently to form bodies. This hypothesis might account for those cases in which the synovial membrane is found to be normal. From the descriptions in the literature and from observation of our own cases it appears that the synovial membrane undoubtedly forms bodies composed of cartilage, bone, or both. In the embryo, the proton of the limb is filled with mesenchymal tissue which later forms bone, cartilage, and synovial membrane. Lexer, building a theory on the teaching of Virchow and Ribbert, concludes that these chondromatous bodies develop from scattered embryologic cartilaginous rests which have resulted from a faulty mesenchymal differentiation during the formation of the joint. Before a joint is formed the cartilages which represent the future bones are separated by undifferentiated mesothelium. Certain of these cells undergo mucoid degeneration and form the cavity of the joint; other cells become spindle-shaped and form articular cartilage, and the cells at the side of the cavity form the synovial membrane (37). The bursal cavities, which are often connected with the joints, undoubtedly are closely related embryologically. Until we know why one group of mesenchymal

Fig. 1 (A414987). Synovial membrane with attached hypertrophic villi and pedunculated bodies.



Fib. 2 (A346313). Bursal sac, from which ten bodies were removed, has been inverted and stuffed with cotton to show the vascular hypertrophic villus (a) and the pedunculated osteocartilaginous body (b).

cells forms a mucoid fluid, whereas another group develops into cartilage, and another into synovial membrane, it will be difficult to determine what causes cartilage and bone to form in synovial membrane.

The appearance of the synovial membrane in osteochondromatosis is characteristic. It is usually loose, wrinkled, pouched, and somewhat congested. Multiple fibrous tags hang from the membrane, but the articular surfaces and the fibrocartilages and intrinsic ligaments in the knee appear to be normal. There is often a little hypertrophic arthritis manifested by osteophytic hypertrophy at the margins of the joints. The fibrous tags vary in size, both in diameter and length. Some are pedunculated, and the tips of the bulbous ends are covered with cartilage (Fig. 1). As these cartilaginous-tipped bulbs increase in size and weight, their pedicles break and they are cast free in the cavity of the joint to wander around and increase in size. On gross section, the bodies are seen to be made up mostly of cartilage. Various degrees of calcification and ossification are seen. Often bone in the interior is distributed at random in small flakes and surrounded on all sides by cartilage.

Microscopic examination in our cases revealed a series of interesting processes. The specimens chosen for study were taken from a bursa (Case 7) removed from beneath the medial head of the gastrocnemius muscle. Since the entire bursa was removed, the lining could be readily inspected and areas chosen for study, an opportunity not present in cases in which a joint is involved (Fig. 2). The vascular hypertrophic villus (Fig. 3) which was one of a great number on the wall of the bursa, illustrates an early stage in the formation of the bodies. Microscopically, it was found to consist principally of connective tissue supporting a great number of capillaries which were especially numerous just beneath the synovial membrane. In one area there were a number of fat cells, but no cartilage or bone was seen. In a few regions, there was definite lymphocytic infiltration.

A pedunculated, bulbous, osteocartilaginous body which was found attached to the wall of the same bursa illustrated a later stage in the process of the formation of loose bodies. This body was found to be a spherical fibro-osteo-cartilaginous shell filled with fatty tissue and spurs of bone. The pedicle, which connected the body to the synovial membrane, was fibrous and avascular; this accounted for the fact that blood-vessels within the attached body were thrombosed and necrotic. The fibrous tissue surrounding the body gradually merged into fibrocartilage (Fig. 4). Deeper than this was a zone of calcified cartilage, and then came a sharp transition to true bone. It was profitable to study the

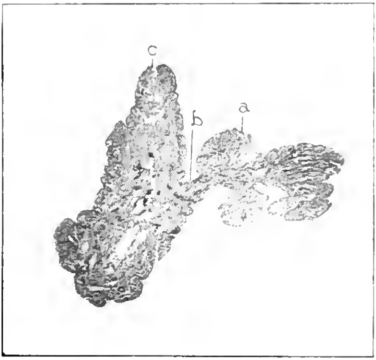


Fig. 3 (A346313). Vascular hypertrophic villus. (X8). a. Villus; b, pedicle; c, wall of bursa.

Fig. 4 (A346313). Pedunculated, bulbous, osteocartilaginous body. (X50) (See Figure 2 b). a. Fibrous tissue surrounding body; b. zone of fibro-cartilage c. line of calcified cartilage; d. bone; e. thrombosed necrotic blood vessels; f fatty center of body; g. portion of fibrous avascular pedicle

state of preservation of the various tissues in the body whose blood supply had been cut off. The cells of the cartilage appeared to have been well nourished, for the nuclei were large and the cells filled the spaces in the matrix. The bone was not so well preserved as the cartilage, for the bone cells showed certain evidences of necrosis; they did not completely fill the lacunae, and many of the nuclei were pyknotic. The absence of osteoblasts also indicated that active bone formation had ceased. The fatty tissue was still fairly well preserved. Well preserved cartilage was found near the surface of the large free bodies; indeed, in certain areas it resembled closely the normal hyalin articular cartilage (Fig. 5). Bone was found only deep within these free avascular bodies (Fig. 6). The tissue was definitely necrotic, for the nuclei were either very pyknotic or not visible, and osteoblasts could not be found. The fatty tissue was almost completely disintegrated.

One of the bodies which was torn from the synovial membrane at the time of operation was examined, and here the condition was quite different from that found in the avascular bodies (Fig 7). In the vicinity of blood-vessels, bone was in excellent state of preservation, as evidenced by the cells of the bone which filled the lacunae and by the presence of osteoblasts. The fat was also well nourished. This body consisted chiefly of thin flakes of bone, a large quantity of fatty tissue, and a small portion of cartilage.

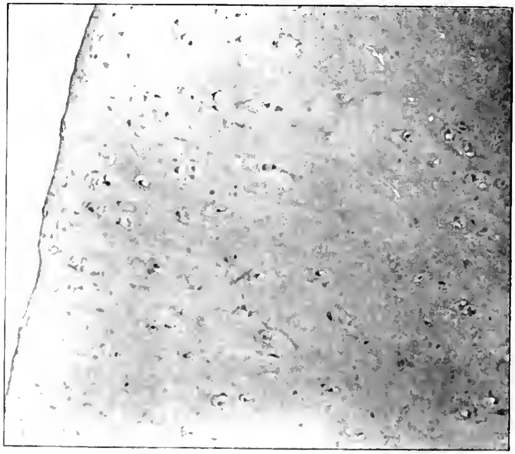


Fig. 5 (A346313). Section of cartilage near surface of large free body. (X100).

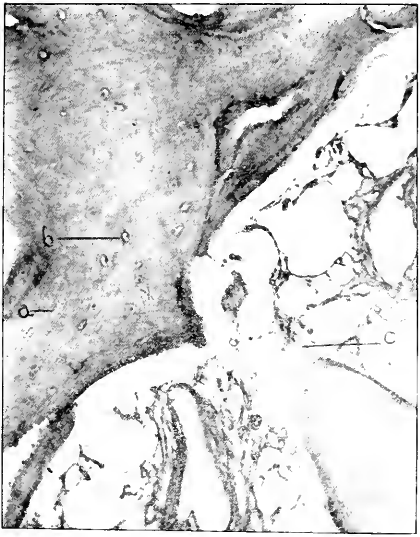


Fig. 6 (A346313). Necrotic center of a large free body. (X100). a, Laminated bone; b, necrotic bone cell with pyknotic nucleus; c, disintegrated fat.

Judging from the condition shown microscopically it is safe to conclude that cartilage may be nourished by the synovial fluid. This bears definitely on the question of the nutrition of articular cartilage. Also, it would seem that active living bone demands a blood supply, a point which has a bearing on the fate of osseous transplants; this, however, is not discussed here.

SYMPTOMS AND DIAGNOSIS.

The symptoms at the onset may be vague, the patient complaining that "things do not feel right in the joint". Then comes definite catching and possibly locking, the anatomic structure of the joint having much to do with the character of the symptoms. A history of trauma, recent or remote, is often elicited. The disability is greater in the knee than in other joints. The knee joint being comparatively super-

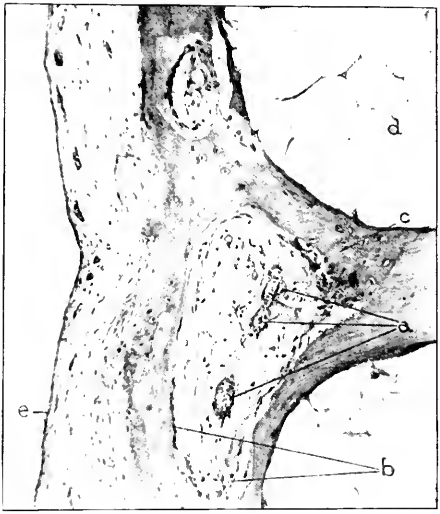


Fig. 7 (A346313). Section of large body with a blood supply. (X100). a, Vessels containing blood; b, osteoblasts; c, well preserved bone; d, well preserved fat; e, membrane covering the body.

ficial, the patient often volunteers the information that he has felt the loose bodies, and on palpation the knee may feel like a sac of marbles. The locking or catching is not so severe as in cases in which one of the semilunar cartilages is at fault, and effusion following an attack is not as marked. The bodies may be carried for years in the suprapatellar pouch, or in the posterior compartment, with only occasional locking. In the elbow joint often the first symptom is inability fully to extend the forearm, and usually this is sooner or later followed by catching or locking. We have observed but one case in the shoulder joint. The symptoms were severe; the catching occurred frequently, and was accompanied by acute pain. Symptoms in the other joints vary according to the anatomic structure of the joint.

Osteochondromatosis in the knee joint may be confused with derangements due to fractured or torn semilunar cartilages, but the presence or absence of loose bodies can be definitely determined by the roentgenogram (Fig. 8). If bodies are present they may be due to

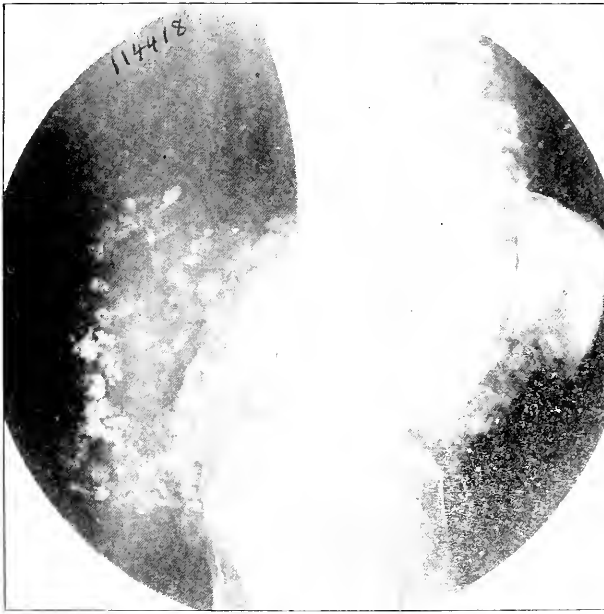


Fig. 8 (A114418). Osteochondromatosis of the knee.

osteochondritis dissecans or osteo-arthritis. In the former, the depression on the internal condyle where the body or bodies originate will be shown in the roentgenogram. In the latter, the marginal lipping is evident and the larger bodies may have a core that casts a denser shadow, and as a rule the patient is older. In osteochondromatosis of any joint, the number of the bodies (twenty-five or thirty are not at all unusual) is the outstanding feature (Fig. 9); the joint is often filled with them (Fig. 10). Beyond this, the roentgenogram does not aid in the differential diagnosis, and only when the capsule is opened for inspection and the typical conditions demonstrated is the diagnosis certain. The bodies are variable in shape and hence the shadows vary. Rounded, smooth, and often slightly oblong forms are attained, particularly in those joints in which the bodies wander freely. In the bursae

Fig. 9 (A240416). Osteochondromatosis of elbow joint.

or tendon sheaths, where less freedom is possible, the bodies are usually more irregular and are of a cauliflower or mulberry type (Fig. 11).

TREATMENT AND PROGNOSIS.

The treatment is essentially surgical. In the literature we have noted such radical procedures as amputation, resection, and synovectomy. We have removed the bodies by the simplest possible route, and as recurrences have been rare, we see no need to change our procedure. Therefore, the operation practically consists of an arthrotomy, the approach to the capsule being the chief concern. In the knee joint the splitting of the patella longitudinally gives the best exposure for a satisfactory exploration of the anterior compartment and the suprapatellar pouch. The ordinary gallstone scoop is convenient in exploring for these

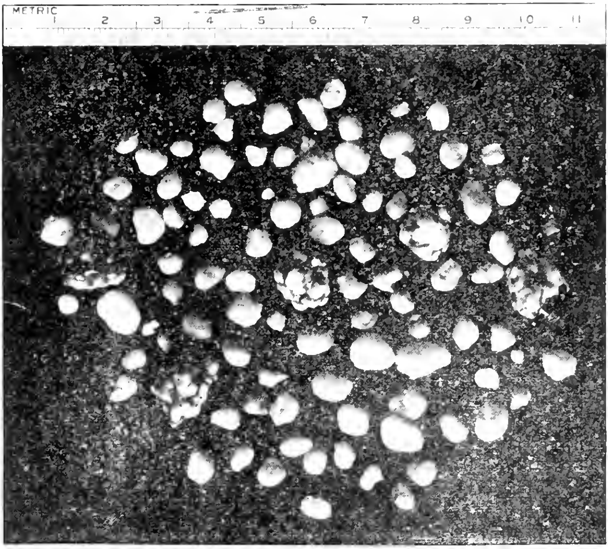


Fig. 10 (A240416). One hundred and seven bodies from the elbow joint.

bodies. If the bodies are in the posterior compartment, the postero-lateral incisions described by one of us ([17]) are convenient. In the shoulder joint the capsule is readily accessible posteriorly, and the bodies may be worked around to the incision. The capsule may be entered anteriorly through the pectoral muscles. In the elbow, the posterior capsule may be opened by a straight incision and the olecranon fossa explored. The anterior portion of the elbow joint may be explored by raising the aponeurotic origin of the flexor muscles from the internal condyle and entering the capsule from that point. By flexing the elbow the scoop may be pushed across the joint to the outer side and even the finger introduced. We have had no occasion to explore the hip joint, but the anterior incision or the posterior Kocher incision should be sufficient for a simple arthrotomy. (Table 1).

Fig. 11 (A393209). Bodies from the flexor tendon sheath of finger.

REPORTS OF CASES.

Case 1 (A131188).—T. K., a farmer, aged forty years, with osteochondromatosis of the right knee joint and chondrosarcoma of the lower right femur, was examined May 19, 1915. Twenty-two years before, he had fallen and broken a bone near the right knee, but had recovered in about one month and had had no further trouble until five years before his registration at the Clinic. He noticed a swelling just above the knee. This had steadily increased, the increase becoming more rapid within the last three to six months. He had limitation of motion and walked with a limp.

On May 27, the knee was explored through a median incision through the patella, and multiple loose bodies, which had clearly originated in the synovial membrane, were removed. A tumor in the lower end of the femur was explored through a separate incision and was reported by the pathologist to be a chondroma. On September 23, on account of a marked increase in the size of this tumor, an amputation was performed in the middle third of the thigh. The pathologist reported chondrosarcoma of the lower end of the femur. Osteochondromatosis did not recur in the knee. On December 13, a roentgenogram of the chest revealed multiple metastatic growths. The patient died March 5, 1916.

TABLE 1. SUMMARY OF CASES.

Case	Sex Age	Part involved	Trauma	Bodies	Remarks
A131188	40 M	Knee	Yes	Multiple	Associated with chondrosarcoma of lower end of femur
A157963	26 M	Knee	Yes	25	
A201151	50 M	Knee and nearby bursae	No	104	
A239850	62 M	Bursa beneath gastrocnemius	No	4	
A243018	29 M	Knee	Yes	1	
A41317	60 F	Knees	No	8	Bodies not removed from one knee
A346313	50 M	Both knee joints and bursae	No	14	
A114418	49 M	Knee	Yes	A great many	No operation
A238014	20 F	Shoulder	No	10	
A126099	37 M	Elbow	No	31	
A196125	26 M	Elbow	Yes	65	
A240416	24 M	Elbow	No	107	
A86594	23 M	Elbow	No	21	
A414987	66 F	Elbow	Yes	3	
A393209	33 M	Flexor tendon sheath of finger	Yes	5	
A38869	28 M	Knee	No	200	
A123360	28 M	Knee	Yes	16	
A272634	26 M	Elbow	Yes	12	

This is the only case in our series in which malignancy was associated. We believe that the tumor in the knee was benign, whereas that in the bone became malignant.

Case 2 (A157963).—J. B. E., an oil driller, aged twenty-six years, with osteochondromatosis of the left knee, was examined April 21, 1916. Ten years before, he had sustained a severe trauma which "dislocated" the knee. Effusion followed for six months and, later, locking.

On April 27, nineteen loose osteocartilaginous bodies were removed from the anterior compartment of the knee joint. The bodies clearly arose from the synovial membrane. On June 23, six loose bodies were removed from the posterior compartment of the joint ([16]).

Case 3 (A201151).—J. Z., a farmer, aged fifty years, with osteochondromatosis of the left knee and bursae about the knee, was examined September 18, 1917. The patient had had a "bunch" on the left knee for two years, which gradually increased in size and caused pain and limitation of motion. There was no history of trauma.

Examination revealed a prominence on the anteromedial aspect of the left knee and a hard mass in the left popliteal space. The roentgenogram revealed multiple mulberry-like shadows; the same condition was shown in the right knee.

On September 15, 1917, and March 11, 1920, multiple loose bodies were removed from the bursae and the capsule of the joint. Also, a chondroma was removed from the upper third of the tibia beneath the popliteus muscle. The patient was only partially relieved of his symptoms. The extra-articular loose bodies were in definite sacs, probably abnormally placed bursae lined with synovia. The synovial membrane of the joint showed many small, pedunculated, cartilaginous bodies.

Case 4 (A239850).—R. P. McT., a retired farmer, aged sixty-two years, with osteochondromatosis of the bursa beneath the right gastrocnemius muscle, came to the Clinic on July 26, 1918, complaining of a growth in the right popliteal space which he had noticed for ten years. For twenty-five years he had had slight attacks of "rheumatism" in the knees. A slightly nodular tumor, which seemed to be outside the joint, could be felt in the right popliteal space. A roentgenogram of the right knee revealed multiple calcified bodies posterior to the condyles.

On August 1, the patient was placed under ether anesthesia and four loose bodies were removed from the bursa under the right gastrocnemius muscle. The bodies measured 2.2 cm., 0.6 cm., 1.9 cm., and 1 cm. in diameter, and we concluded that they originated in the lining of the bursa, because in other areas of the bursal wall were a few attached bodies about 0.15 cm. in diameter.

Case 5 (A243018).—G. J. M., a lumber retailer, aged twenty-nine years, with osteochondromatosis of the right knee, was examined August 21, 1918. He complained of soreness in the right knee and the sensation of something slipping loose in the joint. In 1914, while scuffling, he had twisted the right knee. It "burned" somewhat at the time. One month later he noticed a swelling "the size of a hickory nut" on the outer side of the knee-cap. The body had been felt, but could not be located at the time of examination.

Exploration was advised. On August 29, through an internal hockey-stick incision, a body 2 by 1.05 by 0.05 cm., which the pathologist reported to be composed of cartilage, was removed from the intercondylar notch. Lying around on the synovial membrane and attached to it in most instances, were small flakes of cartilage about 2 mm. in size. Several of the large flakes and a few of the small were removed, and an area of the synovial membrane which contained six or eight.

Case 6 (A41317).—J. L., a woman, aged sixty years, with osteochondromatosis of the right knee-joint, was examined June 26, 1920. The patient complained that since 1908 her knees had ached, the right knee being worse. At times she had pain accompanied by a feeling that something had slipped in the joint.

Roentgenograms revealed arthritis of the right knee-joint, with multiple loose bodies. On July 10, four large and four small loose bodies were removed from the suprapatellar pouch of the right knee-joint. Some of the bodies were still attached to the synovial membrane by fibrous pedicles. Marked hypertrophic arthritis was present. Since the bodies in the left knee were not causing symptoms they were not removed.

Case 7 (A346313).—P. M., a cabinet-maker, aged fifty years, with osteochondromatosis of both knees, was examined January 14, 1921. The patient complained of a smarting pain in both knees on standing, and with motion, of six years' duration. Four years before, loose bodies had been removed elsewhere from both knee-joints.

The roentgenogram revealed multiple loose bodies within the left knee-joint and posterior to each knee. On January 20, the bursa beneath the inner head of the right gastrocnemius muscle was excised, with ten rough, irregular, loose bodies which it contained (Fig. 2). Several small bodies and countless hypertrophic villi were attached by pedicles to the synovial membrane. Two coral-like bodies were removed from the bursa beneath the inner head of the left gastrocnemius muscle, and two more smooth bodies were taken from the joint proper of the left knee.

The incisions were closed without drainage. Microscopic examination revealed the conditions shown in Figures 3, 4, 5, 6, and 7. On January 14, 1921, the patient wrote that he was greatly improved, but not completely relieved by the operation.

Case 8 (A114418).—G. G. H., a farmer, aged forty-nine years, with osteochondromatosis of the left knee, was examined September 3, 1914. The patient complained of limitation of motion and swelling of the left knee. Twenty-nine years before, he had been incapacitated for three weeks because of trauma to the left knee. For twenty-four years he had had no further trouble. Four years before, a swelling developed after hard work. Since then there had been gradual stiffening, and a hard tumor had formed in the popliteal space. There was no pain and the patient was not incapacitated.

The roentgenogram (Fig. 8) revealed dense calcium deposits around the left knee, with normal articular surfaces. The large number of mulberry and shot-like shadows was typical of osteochandromatosis. On examination it was found that the left knee was filled with small, hard bodies which gave the sensation of crepitus when squeezed. One mass seemed to be fixed to the tibia. Motion was somewhat limited. The patient deferred operation.

Case 9 (A238014).—A. H., a young woman, aged twenty years, with osteochondromatosis of the right shoulder, was examined July 9, 1918. The patient complained of pain and aching of the right arm and shoulder, persisting for twelve years. She complained chiefly of sudden attacks of severe pain, lasting about five minutes and followed by residual soreness. These attacks sometimes followed reaching with the arm, which could not be lifted above the head.

The roentgenogram revealed multiple calcified deposits in the right shoulder joint. On July 18, ten loose bodies were removed from the right shoulder through a posterior incision. The site of origin was not determined at the time of operation because the incision was small, and the bodies were worked around until they could be removed with a gallbladder scoop. The large number, the size and consistency of the bodies, and the age of the patient, however, led us to make a diagnosis of osteochondromatosis.

On December 5, 1919, a roentgenogram revealed the recurrence of small loose bodies in the shoulder joint. It was thought best to delay operation. The patient's disability was much less, but she had had occasional attacks of pain.

Case 10 (A126099).—I. O., a farm laborer, aged thirty-seven years,

with osteochondromatosis of the left elbow, was examined March 9, 1915. He complained of stiffness in the elbow, which had been gradually increasing for five years.

The roentgenogram revealed a number of bodies in the region of the left elbow-joint. On March 18, thirty-one intracapsular bodies were removed from the left elbow. The pathologist reported that the bodies were composed of cartilage. Although it was not possible to inspect the synovial membrane, the diagnosis of osteochondromatosis was made because of the large number of bodies, their shape and consistency, and the age of the patient. There was no evidence of hypertrophic arthritis.

On January 2, 1919, the patient returned to the clinic because symptoms had developed in the right elbow similar to those for which the left elbow had been treated. The left elbow had not given trouble since operation, and the range of motion was improved. On January 7, an intra-articular exostosis was removed from the posterior surface of the medial condyle of the right humerus. No loose bodies were encountered in this joint.

Case 11 (A196125).—A. W. H., a locomotive engineer, aged twenty-six years, with osteochondromatosis of the right elbow, was examined June 1, 1917. The patient complained of swelling and stiffening of the right elbow. Thirteen years before, he had stuck a pitchfork into his right forearm. Since then he had had difficulty in flexing and extending the arm. Six years before, he had struck the right elbow on a sharp steel projection, causing intense pain and residual soreness. Later, a "lump" developed in the region of the joint, and for five years pain had been a symptom. Painful locking had taken place frequently during the preceding three years. Flexion or extension, when forced, caused unusual pain. The right elbow was 5 cm. greater in circumference than the left.

The roentgenogram (Fig. 9) revealed multiple bodies of the right elbow. On June 7, sixty-five rounded loose bodies were removed from the joint. The largest was about 2.05 cm. in diameter, the next largest about 2 cm. in diameter; the other bodies were nearly all about 6 mm. in diameter. Small cartilaginous-tipped pedicles were evident at several points on the synovial membrane. There was evidence of chronic irritation of the joint.

A letter from the patient, dated September 3, 1921, says that the arm is painful only as forecast of cold or stormy weather, and that he can work nearly all the time, but believes that bodies are again in the joint.

Case 12 (A240416).—J. M., a farmer, aged twenty-four years, with

osteochondromatosis of the right elbow, was examined July 30, 1918. The patient complained of pain in the right elbow of nine or ten years' duration, and limited motion of four or five years' duration. Two years before, a small "knot" appeared posteriorly. All symptoms had been gradually progressive. There had been no redness. The roentgenogram revealed multiple calcified bodies typical of osteochondromatosis.

On August 1, 107 bodies ranging in diameter from 2.1 to 0.15 cm. were removed from the right elbow joint (Fig. 10). It was demonstrated that they originated in the synovia.

Case 13 (A86594).—J. K., a farmer, aged twenty-three years, with osteochondromatosis of the right elbow, was examined March 12, 1917. The patient complained of pain in the right elbow, which he had first noticed ten months before, while shoveling dirt.

The clinical findings in the joint were negative except for incomplete extension of the arm. Mercury ointment was prescribed.

February 3, 1918, the patient returned to the clinic. For three months he had noticed swelling around the joint. Pain, especially in moving the joint, had continued. The roentgenogram revealed multiple bodies. On January 10, twenty-one loose osteo-cartilaginous bodies were removed from the right elbow-joint. The site of origin was not determined at this time, although it was thought that the bodies were due to osteochondromatosis.

January 9, 1923, the patient again returned to the clinic. He had been fairly well until seven or eight months before, when the right elbow became more painful, especially on use. In front of the medial condyle a movable, hard body could be felt. On January 15, the ulnar side of the elbow was opened anteriorly and a pedunculated body 7 mm. in diameter was found attached to, and evidently having its origin in, the synovial membrane on the anterior wall of the capsule. Free bodies could not be found.

Case 14 (A414987).—S. P., a woman, aged sixty-six years, with osteochondromatosis of the left elbow, was examined January 11, 1923. The patient complained of a tumor in the left elbow. About twelve years before she had fallen on the left elbow, and swelling and some pain had ensued for a week. More or less swelling remained, but there was no pain. In November, 1922, it was noticed that the joint was gradually enlarging. Enlargement had increased rather rapidly, with dull ache, but little pain. Two weeks before, a thin, brown, watery fluid had been aspirated.

In the region of the left elbow there was a large fluctuating mass.

There was no tenderness, but marked crepitation was felt on motion of the distorted joint. Besides osteochondromatosis, the possibility of a neuropathic joint was considered, but careful neurologic examination failed to reveal any basis for the latter possibility. The Wassermann reaction was negative. There was a tardy left ulnar nerve palsy from the changes at the left elbow-joint. The roentgenogram revealed multiple large bodies of the joint. On January 18, 1923, three large loose bodies were removed under local anesthesia. The condition of the synovia was typical of osteochondromatosis (Fig. 1). There was an abundance of fluid in the joint.

Case 15 (A393209).—C. W., a farm laborer, aged thirty-three, with osteochondromatosis of the flexor tendon sheath of the middle finger of the right hand, was examined in June, 1922. Four years before, the middle finger of the right hand had been split and dislocated backward by a baseball. Six months later stiffness came on, and about one and one-half years before examination at the Clinic a hard, movable lump near the base of the middle finger had been noted. At operation, under novocain, five cartilaginous tumors were removed from the flexor tendon sheath (Fig. 11). No definite bony or fibrous attachment was discerned, and the bodies slipped out easily when the tendon sheath was cut. The bodies were all about 1.5 cm. in diameter.

Case 16 (A38869).—J. F. H., a machinist, aged twenty-eight years, with loose bodies in the left knee, was examined June 14, 1910. Three and one-half years before, stiffness and soreness had developed in the left knee. There was no history of injury. Locking was frequent. On June 16, about 200 small loose bodies were removed (by Judd) from the left knee-joint. Unfortunately, these were not preserved for study, and the roentgenograms of the case were destroyed. The large number of bodies and the age of the patient leads us to believe that this is a case of osteochondromatosis, but in the absence of definite proof we have classified it as doubtful.

Case 17 (A123360).—W. L. M., a farmer, aged twenty-eight, with probable osteochondromatosis of the right knee, was examined January 26, 1915. Eight years before, he had been kicked in the right knee and had limped for several months. Occasional locking followed. Several bodies had been removed from the joint elsewhere.

Operation was advised, but was deferred until July 14, 1921, when sixteen loose osteocartilaginous bodies were removed, eight from the posterior compartment through posterolateral incisions, and eight from the anterior compartment. It was difficult to determine the exact site of origin, but the operative record said that the bodies appeared to

originate in the synovial membrane and possibly also in the intercondylar notch.

Case 18 (272634).—I. K., a farmer, aged twenty-six years, with probable osteochondromatosis of the right elbow, was examined May 29, 1919. Seven years before, the patient had fallen and injured his right elbow. Since then the elbow had pained, especially on throwing, and there had been frequent lockings. Limitation of motion was noted. At the time of examination some crepitus was present in the right elbow-joint, but no pain. He had had some rheumatic pain in the knees.

The roentgenographic examination revealed multiple loose bodies of the right elbow, and on December 11, 1920, twelve bodies were removed. There was marked hypertrophic arthritis. The pathologist reported osteocartilaginous loose bodies (Table 1).

DISCUSSION.

The chief interest attached to this subject is the etiology. In the review of the records that we have at hand in the Mayo Clinic of loose bodies in joints, we have often been at a loss definitely to classify them. We have definitely attributed fifteen to osteochondromatosis. The appearance of the synovial membrane is characteristic, and the cartilaginous bodies can be seen in various stages of development. The opportunity is not always afforded of inspecting the synovial membrane as, for instance, in Case 9. In this case, as in a few others, the number, size, shape, and consistency of the bodies, and the comparative youth of the patient, led us to believe that the marginal osteophytic lipping was in reality a part of the osteochondromatosis. The point of reflection of the synovial membrane from the joint in the adult is the point of differentiation in fetal life. It certainly is a most favorable situation for a disarrangement of cells that may later in life take on properties which are not normally relegated to cells in this situation. It is reasonable to believe, therefore, that the marginal lipping is in reality due to activity of these cells in the folds of the synovial membrane at the marginal recesses of the capsular cavity.

We have accepted as osteochondromatosis of the synovial membrane only such cases as we have been able to prove by visual inspection (twelve cases), or cases which, by the number of bodies, their size, shape, and consistency, and so forth, seemed to fulfill the conditions (three cases). In three others (Cases 16, 17 and 18) we believe the bodies were due to osteochondromatosis, but we have hesitated to classify them definitely as such.

CONCLUSIONS.

1. Osteochondromatosis of the synovial membrane is one of the causes of osteocartilaginous loose bodies in the joints, and probably the sole cause of the bodies in the bursae and tendon sheaths.

2. We believe that the condition should be classified as a benign neoplasm. Trauma is a secondary factor.

3. One of our cases was associated with a malignant chondrosarcoma in the lower end of the femur. No malignancy was discovered in the knee-joint.

4. Removal of all the bodies relieves the patient in the majority of instances. We have not found amputation or resection necessary for synovial osteochondromatosis.

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THE EVOLUTION OF FRACTURE TREATMENT, OR WHAT HAVE BEEN THE REAL CHANGES

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IN reading over the chapters on fractures in the works on surgery which have been printed during the past hundred years, it is interesting to note the very clear description that is found in the text in practically all of these books on the points which are present-day essentials in the management of fractures. The variety of fracture, the direction of displacement of the fragments, the mode of repair, the symptoms and prognosis are in a general way the same as are found in modern text books. It appears they have been rewritten and rewritten from time to time through all these years, with very little change.

The following quotations are taken from some of these books printed from sixty to eighty years ago, bearing upon the general subject of fracture treatment:

Regarding fracture-dislocation at the shoulder joint, Charles McBurney in "Annals of Surgery," Vol. XIX., 1894, says: "The injury which is the subject of this paper has received careful study from numerous observers since a very early period, and the attention bestowed upon it has been much greater than I was at all aware of until, with the invaluable aid of Dr. Charles N. Dowd, I was able to study its history. It is interesting to note that so long ago as fifty years before Christ, Pasicrates described the injury, recommending reduction of the dislocation first and treatment of the fracture afterwards, and Aristion, Heliodorus, Paul of Egina, Guy of Chauliac, and others, all recognized the importance of the injury and the difficulties encountered in its management. In 1839, Sir Astley Cooper, who was fortunate enough to meet with three cases, when reporting them, says, 'Every intelligent, well-informed surgeon will now confess that no knowledge or exertion of skill could have prevented the deformity and loss of the natural motion which results from this formidable accident.'

"This statement is certainly not supported by subsequent history, for, owing to fortunate ease of reduction, a number of cases have been successfully treated.

"In 1843, Riberi reported a case which he had treated by passive motion so as to establish a false joint at the point of fracture, the

dislocated head of the humerus being left unreduced. The method of treatment made use of in this case is still known by the name of Riberi.

"In 1852, Richet read before the Surgical Society of Paris the history of a case of fracture of the neck of the humerus with dislocation of the head, and a very full discussion of the subject followed, and in 1884, appeared the thesis of Oger, in which were collected and compared the records of eighty cases, and many facts in regard to the frequency of the injury, its pathology, and the results which follow it were presented.

"A most satisfactory discussion of the subject is to be found in the book on dislocations by L. A. Stimson, and in the Revue de Chirurgie, 1892, is a very complete paper by Poirier et Mauclaire, in which fracture of the humerus with dislocation of the head is studied at length, and additional cases are given.

"The accident is a rare one, for a careful extended search has revealed the records of only 117 cases, and no single observer has met with more than five. Of course, there are many unreported instances."

The following is a quotation from a work published in 1845 by Mr. James Miller, Professor of Surgery in the University of Edinburgh, Scotland:

"The treatment of fracture may be said to consist of three parts, reducing the fragments to their proper position, retaining them so, and preventing redisplacement or other evil consequences.

"Reduction is effected without force and gradually. With one hand, the limb is grasped on the distal aspect of the fracture, and extension made gently yet determinedly, the limb being at the same time placed in such a position as to ensure relaxation of these muscles most likely to oppose this movement.

"Retention is effected by the fulfillment of two obvious indications: First, by keeping the limb in such a posture as shall relax those muscles which we know to be the most busy and powerful agents of displacement. Secondly, by applying mechanical means externally to the fractured part, adapted to prevent motion. These mechanical appliances are termed 'splints'. They are variously constructed, but all with one object in view—to rest lightly and easily on the part and yet be successful opponents of motion in the fragments. They may be made of iron, as the double inclined plane so useful in most fractures of the leg; or of wood, as the ordinary splint for fractured femur and fractured fibula; or of pasteboard, as in fracture of the bones of the forearm; or of leather, like the splints found so useful in the chronic affections of the joints: or of soft materials saturated with gum or starch, which become tightly adherent as well as accurately fashioned to the part.

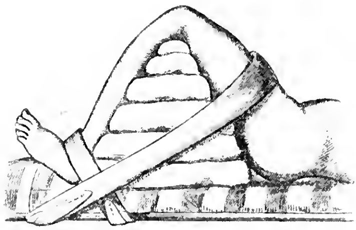


FIG. 257
1856
FIG. I

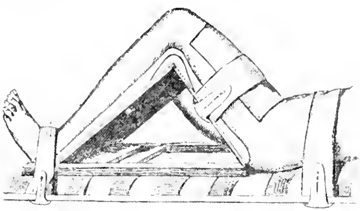
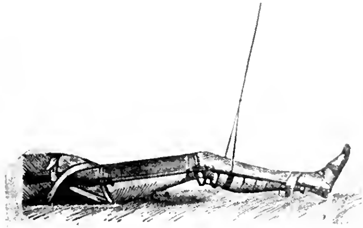


FIG. 258
1860
FIG. II



Nathan R. Smith.
FIG. 281
1863
FIG. III

"The wood, iron, and pasteboard splints are those most commonly in use, and most generally applicable. They are retained by bandaging, uniformly and evenly applied, not so slack as to admit of any motion between the fractured ends, and not so tight as to endanger undue pressure or constriction, either on any part or on the whole limb. The first application of the bandage should always be rather too slack than otherwise; allowance being made for the swelling and engorgement which are certain to occur, to a greater or less extent, in the course of a few hours. The splints should invariably be of sufficient length to command the neighboring joint or joints; otherwise, by rotation, voluntary or involuntary, redisplacement will certainly be effected.

"Daily dressing, manipulation and movement may, in the eyes of the ignorant, express great care and anxiety and even skill on the part of the practitioner; but in the minds of the well informed, the same evidence convicts him of glaring malapraxis. It is most essential for due advancement of the process of reparation that the uniting parts should be placed and retained in a state of absolute repose. Watchfulness and meddling are widely distinct. We can not satisfy ourselves too often, from examination both by sight and touch, on the outside of the apparatus, and also by regard to the general state of the system, that all is advancing favorably at the site of fracture; but at the same time, we can not too seldom interfere with the position of the limb when this continues accurate and easy."

In 1834, Miller says, "An attempt has recently been made to supersede almost all other splints by those of gum or starch. This form of splint is applied in the same way as recommended in the treatment of chronic affections of the joints. It is of easy adaptation, looks well when applied, and is promising of much benefit, forming a tight, accurately fitting, unyielding case, in which the broken bone lies securely imbedded. Under certain circumstances its use is in all respects admirable, but its indiscriminate employment tends manifestly to injury. During the first period of the treatment of severe fractures it is quite unsuitable, for considerable swelling must occur, requiring proportionate slackening of retentive apparatus which ought consequently to be light and easily changed. Further on in the case, when the swelling has reached its acme, and has begun to subside, it is still inappropriate; if applied today, the limb will have shrunk so far by tomorrow that the apparatus has ceased to be retentive. If then employed at all, it must be almost daily renewed, and that is foreign to the nature of the application. It is only during the later periods that its use becomes judicious. When the time for inflammatory swelling has gone by, and when further decrease of the

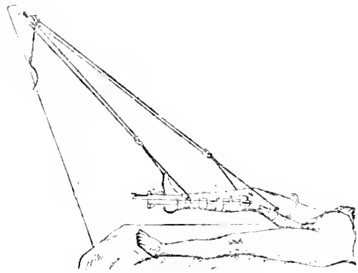
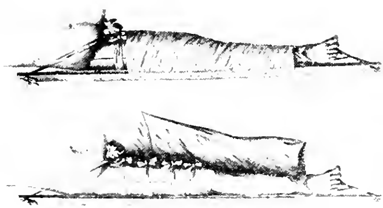


Fig. 80
Hodgen's Splint
Fig. IV



DeSault's Fraction Splint from James Syme's, 1842
Fig. V

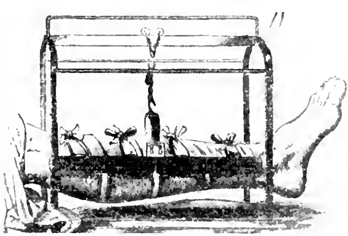


Fig. 292
1863
Fig. VI

more or less swollen limb is improbable, then the permanent, fixed and unyielding nature of the application ceases to be detrimental and becomes most salutary. If used sooner, it ought not to be in mass, but after bisection, so that the apparatus then comes to resemble two neatly and closely fitting splints of the ordinary kind."

In 1845, Miller says further: "In the case of an obstinately 'rising end' of a bone, it may come to be a question whether or not pressure should be employed, as by compress and bandaging, to force it into its normal position. In general, this question is to be answered in the negative. The pressure, unless very severe, is not likely to succeed, perhaps may fail even then, and is apt to occasion ulceration or sloughing of the integuments, or abscess more deeply seated; events all most unfavorable to the process of cure. It is better, by attention to position, to relax the muscles which are causing the displacement and to bring the other fragment higher in its level, until a smooth and continuous readjustment shall have been thus attained. Most certainly, when the rising of the end is only apparent and not real, as in the case of the clavicle, nothing can be more unwarrantable than the application of pressure to the part which is in truth undisplaced."

In 1843, Miller may be further quoted: "In treatment the paramount indication is reduction, and can not be attempted too soon. It consists of extension to move the bone from its normal position and bring it on a plane with the articulating surface it has left; counterextension to steady the latter part and admit of extension being satisfactorily effected; and coaptation to replace the surfaces in apposition. If the patient be seen immediately after infliction of the injury, yet faint, with all his frame prostrate and relaxed, and incapable by any effort of throwing any part of his muscular system into strong resisting action, reduction may be expected to be comparatively easy. The surgeon is able to cope with the accident single-handed. In the case of the shoulder, for example, he takes hold of the elbow with his right hand, and gently extends the arm, while, with the fingers of his left hand, he pushes the head of the bone toward the glenoid cavity. After moderate extension he makes a sudden, combined, jerking movement, and usually succeeds."

It was early recognized that all fractures of the upper third of the femur should be treated by elevating the lower end of the femur, either with the knee flexed at a right angle or at some angle. Figures Nos. 257 and 258 show steps in the development of this idea. They were taken from H. H. Smith's book; volume 1, published in 1863. Figure 281 from the same book, a description of which was published in Golden's Baltimore Medical and Surgical Journal in 1833, and which was also published as per the description, in 1849, is the design of Nathan R.

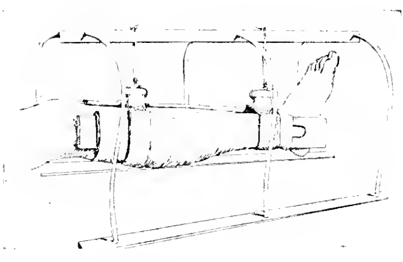


FIG. VII

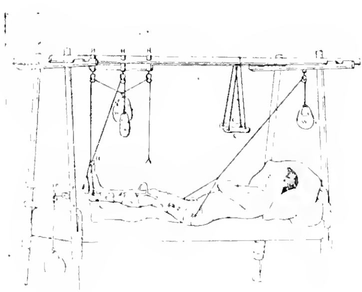


FIG. VIII
The above is the Blake frame.

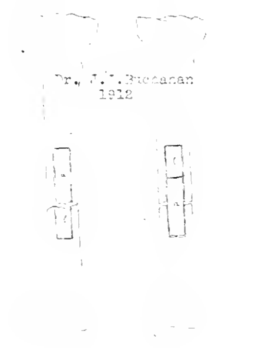
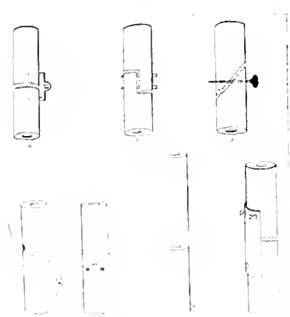


FIG. IX

Peter's Forceps (from Cheyne and Burghard.)
FIG. X



Different Methods of Uniting the Ends of a Long Bone.
FIG. XI

Smith of Baltimore. Further development of the idea may be seen in Figures 282 and 283, as used by Nathan R. Smith and published in H. H. Smith's Surgery, volume I.

After this time Hodgen began using a modification of this idea, as is shown in Figure 80, and is a further use of Buck's extension with elevation of the extremity with the knee in slight flexion.

I think it is proper to submit for your inspection Figure 292 from H. H. Smith's Surgery, an illustration of De Sault's apparatus, as well as the Cheyne method of suspending the leg, both of which are for the purpose of treating fractures of the leg by suspension and elevation.

Must we not see in these various methods of treating fractures of the lower extremity all of the elements of refinement and of practical benefit, the evolution of which may be shown in Figure 127.

It will be of interest to the younger members of the profession to read the list of papers copied from H. H. Smith's bibliographic index, an exhaustive list of all articles printed on the subject of fractures, and, indeed, every surgical subject previous to 1863.

If the list of apparatus is studied, one must come to the conclusion that there are very few new principles in the construction of the modern apparatus, with the exception of making them of metal and sanitary, rather than of wood and fabric.

I submit several illustrations showing the earlier methods of bone fixation. Dr. J. J. Buchanan of Pittsburgh was one of the earliest users of bone grafts, and the illustration shown was published in 1912, but had been used a number of years previous to that date.

The two other illustrations in this group represent practically all of the other methods of fixation.

You must also be reminded of the methods of fixation introduced by Professor J. William White, as well as the Parkhill plate.

What is the Thomas' ring but the ambulatory method shown in De Sault's fracture splint from James Sims, 1842? Dr. Horner, of Philadelphia, as early as 1826, used this method of treatment, as may be seen in Figure 274 from H. H. Smith's book.

ADHESIVE PLASTER.

Cheselden, in his Anatomy, published in 1740, speaks of the use of adhesive plaster, the late Dr. S. D. Gross advocated its use in 1850, and Dr. J. N. Quinbey wrote a paper on this subject in 1867. (Judson.) From that time to the present date it is increasing in favor.

The following quotations are taken from H. H. Smith's Surgery, published in 1863:

"Passing over the ancient methods of preserving extension when it has been made by the hands, I shall limit this account to that obtained

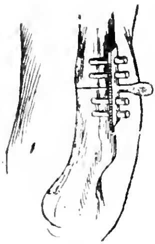


FIG. XIII

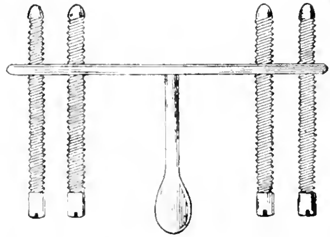
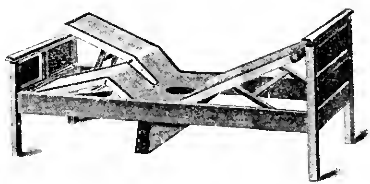


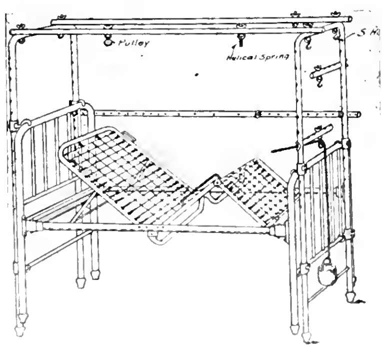
FIG. XII

The above method of securing fixation of fractures is that of J. William White of Philadelphia, and was used by him. It is evidently one of the earliest methods of fixation.

FIG. 292



McCurdy's Fracture Bed, 1888.
FIG. XIV



Devised by Dr. Nathaniel Allison of St. Louis.
FIG. XV

The evolution of the fracture bed may be briefly illustrated in the two figures above.

by the use of adhesive plaster, the utility of which has been so marked as to bring forward several claimants for the suggestion, as Gross and E. Wallace of Philadelphia, and Crosby of New Hampshire. Of the priority of these claimants it is difficult to decide, but it was certainly but little known or used in Philadelphia until Wallace called attention to it.

"In few fractures have surgeons suggested more varied plans of treatment than in those of the femur. Without attempting even to mention all of these, I would advise the inexperienced practitioner to take the simplest that is adapted to the case, and to shun all the patented, costly, and usually very attractive forms of apparatus sold by inventors and their agents.

"Then, to prevent any recurrence of the displacement from muscular action, the straight position of the entire lower extremity maintained by splints, with good extension and counter-extension, is the best plan of treatment.

"Counter-extension. This, like extension, is best preserved by attaching the limb to the splints by means of adhesive strips, as suggested by Gilbert, of Philadelphia."

"Gaston of South Carolina has also employed counter-extension by means of adhesive plaster by warming a strip two inches wide and applying it closely over the groin, spinous process and crest of the ilium as far as is possible, carrying the other end of the strip through the top of the external splint while a second is made to adhere to the trochanter major, and thence up and behind as far as possible before passing to the splint. By these attachments he claims to gain two firm points of attachment, owing to the close adherence of the skin to the bones at these points."

The following extract taken from an article written by Joseph A. Blake clearly shows that the so-called Balkan frame was designed by him:

"On assuming charge at Hospital B, American Ambulance, Juilly, Seine et Marne, in February, 1915, we were immediately confronted with the practical difficulties of dressing complicated compound fractures of the extremities. From the standpoint of the surgeon these dressings were time-consuming, difficult, and unsatisfactory; to the patient they were long-drawn-out ordeals of pain. With the limited personnel at our disposal it was obvious that we must evolve a more satisfactory method of handling these cases. At this time we were receiving our wounded by ambulance direct from the French field hospitals."

We believe that the so-called Balkan frame should be called the Blake frame in justice to Dr. Blake's work and for the reason that it is difficult, so far as I have been concerned, to trace the origin of the word "Balkan." (Fig. VIII.)

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TREATMENT OF TUBERCULOSIS OF THE KNEE JOINT IN CHINA

Resume of Paper Presented at the Meeting of the China Medical Missionary Association, Shanghai, China, February 14, 1923.

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Treatment of joint tuberculosis so as to eradicate the disease, and, at the same time, obtain a satisfactory functional result is one of the most difficult surgical problems. This is especially true in China at present, for the reason that most cases present themselves for treatment only in the advanced stages, and for the reason, also, of the poor economic condition of the people, the scarcity of hospital beds, the absence of social service to assist financially and of visiting nurses to do follow up work, and also the lack of convalescent homes. In most cases, the problem resolves itself into a question of giving the patient a functional result in order that he may earn his living as early as possible.

In this paper, there is considered the treatment of tuberculosis of the knee. The desired end result is a bony ankylosis, which may be obtained by conservative means which require an extensive period, or by a surgical procedure requiring a much shorter time. One of the drawbacks to conservative treatment, aside from the uncertainty of obtaining a bony ankylosis, is the length of time necessary. A fibrous ankylosis as a functional result for a working man is not satisfactory because of the slight motion and the pain due to adhesion, and a resection of the joint must be performed in the end. Resection of the knee joint for tuberculosis is an old, tried, and satisfactory method of treatment in the West. Its application has certain definite, fixed conditions, but owing to the late stage in which disease is usually seen in the East and to the poverty of the people and the necessity of getting the patient back to work as soon as possible, as well as to the lack of charitable assistance and of hospital space, the conditions in the application of this surgical measure are different. It is from this point of view that we present the subject.

The subject of tuberculosis of the knee may be divided into three stages: early, intermediate, and advanced.

1. *Early stage.* Before marked synovial or joint changes have taken place, the diagnosis and treatment of the knee may be very difficult, and it must be remembered that the condition under which diagnosis must be made here in the East is different from that in the West. The two may hardly be compared. There is so often the history of injury that one may look upon the condition as a chronic traumatic arthritis. With the exclusion of gonorrheal urethritis or syphilitic infection, one must be suspicious of tuberculosis. With the positive diagnosis of tuberculosis made, what may be the treatment in this early stage? The treatment is difficult because the temptation is to be conservative where perhaps radical methods should be chosen. There must first be considered the economic and social condition of the patient and the limitation of bed space. In all adults, except in the well-to-do, in whom there is no pulmonary process, we believe that resection of the joint should be performed as soon as the diagnosis is made. In the well-to-do, when good home conditions are available, and an indefinite period of rest may be relied upon, we would try conservative treatment (cast or Thomas splint) so long as there appears to be no progression of the disease. If, after a reasonable period, nine months or a year, there is no improvement or evidence of return to normal, or if there is evidence of progression of the process, resection of the joint seems to us to be clearly indicated. Even with these adults who can be placed under good economic conditions, it is a grave question in our mind whether resection of the joint should not be advocated as soon as the diagnosis is made. In children, in this stage of the disease, we should carry out the conservative treatment unless there were signs of the failure of the general condition.

2. *Intermediate stage.* In the presence of marked synovial thickening, moderate limited motion, the picture, considered with a history of remission extending over months or a couple of years or more, is typical. The diagnosis is fairly simple. However, there is a monarticular syphilitic synovitis, probably the beginning of a Charcot's joint, which clinically may be taken for a tuberculosis of the knee in an early or intermediate stage. Two such cases have been encountered. The synovial thickening and limitation of motion were less than in the tubercular form. There was no evidence of fluid in the joint. Positive Wasserman confirmed the diagnosis. In this intermediate stage of tubercular infection, without regard to the economic condition, and when the pulmonary condition is good, we believe that prompt resection

should be advised. In children, when the home condition is good, a period of a few months of conservative treatment under close observation should be given trial. When home conditions are poor, resection should be performed at once. We believe that these moderately advanced cases progress from bad to worse, and, therefore, the earlier resection is done, the better.

3. *Advanced stage.* It is in this advanced stage that one sees the greatest number of cases in China. From the point of view of treatment, they present the greatest problem. The intermediate and advanced stages more or less merge into one another. The border line is not sharply defined. Many of the advanced cases, particularly with sinuses, do not leave room for doubt as to their classification. These cases are of long duration and come to the hospital as a last resort. With experience in only one case with sinus, and in which the condition was excellent, and in which resection gave a fairly good result, we feel encouraged and willing to attempt radical treatment in advanced cases with sinuses, realizing the seriousness of resection in cases with sinuses and in which there is a secondary infection present. Without resection, it would have been a question of amputation or a very long period of rest in the hospital, with the indefinite hope that the sinus would heal and that resection could then be resorted to. In spite of the greater risk, it gave this patient a good leg in a reasonable length of time. Resection in this case needs more extensive trial or else must be urged because of the lack of proper economic conditions before it can be advocated. When the method of mortising the two bones is used and no foreign body put in for retention, and a good application of cast is made, the danger is less than in the case above, for in this case a steel plate was used to unite the two bones. There may be in these cases a severe local infection with complete breaking down of the wound, but with careful treatment of the wound, if the general condition of the patient is good, the infection will subside. When there has been a separation of the skin edges, and when the granular tissue has reached the level of the skin and has become healthy, the pin point skin grafts will hasten the wound closure. In those cases where the patient's condition is not good, and if there is pulmonary complication of even mild form, the amputation is advised. In children, there is the same choice, although when the general health is good, we would advise a few months of general treatment to obtain improvement if possible, and to then attempt a resection. If, on the other hand, after six months of hospital treatment, there is no improvement, amputation should be done.

This should be done earlier if there are signs of failure on the part of the patient.

These principles of treatment may seem somewhat radical as compared with those of the West, but the difference in economic conditions of the people and the scarcity of beds must be considered. During a visit in China in the spring of 1922, Dr. E. G. Brackett became very strongly of the opinion that in the East, much more radical methods must be used because of these conditions and the necessity for the patient to be early restored to earning capacity.

OPERATIVE PROCEDURE.

Preparation of the leg on two successive days was done in all cases. A horse-shoe incision, convexity downward, flap of skin and superficial fascia dissected upward; patella removed; the joint thoroughly exposed; the synovial membrane with its tubercular granular tissue removed but no attempt made to dissect it all away; slices as thin as possible were removed by the saw from the tibia and femur. These pieces were cut so that an angle of about twenty-five degrees from full extension was formed when the bony surfaces were held in contact. In six cases, holes were bored obliquely on each side through the two bones, and heavy kangaroo tendons threaded through and tied. In one case, an intramedullary bone graft was placed, uniting the two bones firmly. In one case, thin slices were sawed from the condyles and chiseled from the head of the tibia, leaving a wedge which fitted snugly into a notch cut between the condyles. An angle of twenty-five degrees from the full extension was easily maintained on account of the snugness with which the wedge and notch fitted into each other. This is the mortice method. After the wound was sutured, a plaster cast was applied, extending high on the thigh and including the foot. A hole was cut through it to observe the wound.

In four cases of plating in which casts were changed before leaving the hospital, there was bony union in three, at the end of five months, and a fibrous union in one, at the end of seven. In five cases where only kangaroo tendon was used and the cast changed before the patient left the hospital, there was bony union in three, at the end of six months and fibrous union in two, at the end of eight. In five cases, plates were used to stabilize the two bones. All of these plates had to be removed in the course of time, in some, under local anesthesia. Sinuses had formed in all of these five cases. In the case in which the intrame-

dullary bone graft was used, and in the case in which the mortice method was used, no sinuses occurred.

From these cases, it is seen that joining the bones with the kangaroo sutures gave better results, but took a longer period. Sinuses always occurred when the plates were used, but bony union took place more quickly. In one case where kangaroo sutures were used, there was still fibrous union after ten months, and a second operation was done and a plate put in position to hold the bones in apposition.

In resection in children, one cannot be too careful about avoiding the epiphyses. Just enough cartilage should be removed to expose the underlying bone. If the disease is so extensive that it involves the epiphyseal line, there must necessarily be an arrest of growth, and a shorter, useless limb. In this case, amputation is advised.

SUMMARY OF CASES.

Records are of six cases, all of which are well and have a good functional result at a period ranging from nine months to four years after operation. From three other cases no reply has been received, but their immediate operative result and general condition would warrant an opinion that these also were well. One case now under observation and in good general condition has almost firm union and is promising a favorable result. The report of one case received indirectly gives complete healing and firm union but patient experiences some difficulty in doing her work. This case was the one which had a sinus at the time of resection. One case reports a sinus at the end of a year, but this is not particularly uncommon, and if the general condition is good, there is no reason why the sinus should not be expected to heal. One case now in the hospital has not yet developed a firm union after a period of fifteen months. There are, therefore, six positive cures, three probable cures, one case improved, two cases under observation with favorable outlook. One case at a distance, of which complete records are not available, has still a sinus, but apparently union is taking place.

CONCLUSIONS.

1. Both with adults and children in poor economic conditions, with no pulmonary contra-indication, resect joint as soon as a positive diagnosis is made.

2. In adults, during the early stage, with good economic conditions, conservative treatment (splint or cast) may be used as long as there

seems to be no progression of the disease. (Even here, we are inclined to advise resection as soon as diagnosis is made.) In children, in the early stage, with economic and home conditions good, the conservative treatment should be given a trial. Should there be no improvement after nine months or a year, or should progression of the disease be evident, resection is to be advised, provided there is no pulmonary contra-indication.

3. In adults, with general condition poor, or with incipient pulmonary tubercular process, amputate above the knee.

4. In children, in poor general condition or with incipient pulmonary tubercular process, conservative treatment should be attempted for about six months. Should the general condition not improve, amputation should be advised.

5. When the general condition of the patient is good, the presence of a sinus from the joint is not a contra-indication for resection of the joint. It is realized that this is a radical step, and not without danger, but under good operative conditions, it may be attempted in order to save the patient time, and, considering conditions in this country, to save bed space. This is advised with the consideration that conservative treatment gives no sure hope that the sinus will heal, and also in consideration of the fact that, should it heal, resection would be indicated.

6. The mortising of the two bones is the operative choice.

7. The joining of the two bones together by bone plates gives a quicker bony union than uniting the bones with kangaroo sutures passed through holes upon the two sides of the leg.

BILATERAL ASYMMETRICAL CESSATION OF GROWTH OF UNKNOWN ETIOLOGY IN EPIPHYSES.

BY R. D. SEVERANCE, M.D., ROCHESTER CLINIC, ROCHESTER, N. Y.

We wish to place on record a case presenting an asymmetrical bilateral cessation of growth of the metacarpals. The deformity was first noticed in the left hand about one year ago, shortly afterward in the right; both have progressively increased. It could not be definitely ascertained that there was an interval in the onset in the two hands. There is no history of injury, disease, mal-nutrition, or any other etiologic factor. Patient has had the usual uncomplicated children's diseases. The mother and father are alive and well. No hereditary influence was obtainable in the history.

PHYSICAL EXAMINATION.

Normal, healthy, well developed girl of ten years, presenting no abnormalities except the hands. *Left* hand: index and fourth fingers are of the same length—apparently normal. Third and fourth fingers appear shortened. The distal phalanx of the thumb also appears shortened. The knuckle line is irregular when the fingers are extended; this is markedly increased when they are flexed. *Right* hand: Thumb and index finger appear normal. Third, fourth, and fifth fingers show increasing shortness in that order. The knuckle of the index finger is very prominent; others recede progressively to the fifth. The soft parts are apparently well developed and normal in contour and size. No scars or limitation of motion at any of the joints. The function of the hands is not disturbed.

The accompanying table and x-ray picture will show the exact relationship of the various bones. Attention might be called to the relative increase in size of the distal extremities of the affected metacarpals and the absence of the epiphyseal lines. The thickness of the cortex and the diameter of the diaphysis seem to be increased.

Darbois & Chevallier* report a case of cessation of growth of the left fifth metacarpal of unknown etiology. In their case, the left fifth meta-

*Darbois & Chevallier—Bull. et Mem. Soc. de Radiol. de Paris, 1910, 11, 286-289. Brachymélie congénitale du cinquième métacarpien gauche.

carpal was 12mm. shorter than the right. They also noted that the distal extremity was enlarged, the diaphysis thicker, and the medullary canal increased in diameter.

We feel that this case represents a disturbance of growth—in fact a cessation of growth—of the distal epiphysis of the affected metacarpals. We are unable to offer any plausible theory for its cause.

TABLE OF MEASUREMENTS FROM X-RAY (Millimeters)

Digit	Length				Width of Extremity				Width of Shaft	
	Finger		Metacarpal		Distal		Proximal			
	L	R	L	R	L	R	L	R	L	R
1st	47	50	39	41	12	12	13	13	10	10
2nd	78	78	58	57	12	13	17	18	8	8
3rd	*89*	*86*	*40*	*40*	*16*	*16*	*13*	*13*	*8*	*7.5*
4th	85	*81*	45	*37*	11.5	*13*	11.5	*11*	6	*6*
5th	*64*	*64*	*35*	*34*	*12*	*13*	*13*	*13*	*7*	*7.5*

Foot Note—Measurements recorded in italics are of the affected digits.

SOME ETIOLOGICAL FACTORS IN SURGICAL TUBERCULOSIS OF CHILDHOOD.*

BY WALLACE H. COLE, M.D.

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ALTHOUGH the etiological factors in bone and joint tuberculosis are in the main well worked out and understood, it is not unwise at times to review them in the light of experience and see whether the general teachings are still corroborated by later series of cases and whether anything new can be added to the facts already known. With these ideas in mind a study was made of the histories of all the cases of surgical tuberculosis which had been admitted to the Minnesota State Hospital for Crippled and Deformed Children since 1914, and the results of this study form the basis of this paper. Nothing strikingly new was discovered, but enough interesting data was compiled to warrant its being used for such a purpose. Two hundred and five histories were examined, this being the number of cases admitted since the time indicated, but only 193 of them were found to contain enough data to allow them to be included in most of the studies.

There is, of course, only one actual cause of tuberculosis anywhere in the body, and that is the tubercle bacillus. Both the human and bovine types infect the human body and have been isolated either alone or together from infected bones or joints, but the percentage of each is far from constant and varies greatly in the different series that have been worked out and reported. The chief factors causing this variation seem to be the age of the patients and the geographical location of the cases studied. Fraser of Edinburgh found 60 per cent of his 70 cases to be due to bovine infection, while in Germany, France, and this country, the incidence of this type is apparently so much less that in some series it is almost nil. Fraser assumes that the use of milk from infected cows is the underlying cause for the bovine infection in his cases, and it is certainly reasonable to suppose that this factor is the most probable. In this country, however, where the milk supply is

*Read by invitation before the Consulting Medical Staff of the Lymanhurst School for Tuberculous Children, January 23, 1923.

fairly well controlled, such a source is probably of minor consideration. The report of the Imperial German Board of Health, in which an analysis of 1400 cases regardless of location in the body is given, shows the results of investigations in that country. Out of the total number of cases there were only 128 which were infected with the bovine type of bacillus, 115 of these being patients with generalized or glandular involvement. Ninety-nine cases of bone and joint tuberculosis were investigated and included in the series, and of these, 95 showed the human type of infection and only five the bovine. Recent postwar observations in Germany have, however, shown a great increase in the percentage of bovine cases, due, it is explained, to the lack of the supervision over the milk supply which was formerly present. Eastwood and Griffith in England studied 261 cases of bone and joint tuberculosis and found the human type of bacilli in 196 and the bovine type in 55. The remaining 10 cases were of an unclassifiable type. As worked out in percentages they showed that for all ages, 21.1 per cent of their cases were of the bovine type but that in the cases under 10 years of age this rose to 29 per cent, while in the cases over 10 years of age only 9.4 per cent were so infected. No bovine infection was found in any case over 25 years of age. Other investigations could be quoted, but their general trend is the same and the whole subject of the type of infection can be briefly summarized somewhat as follows:

Although both human and bovine strains of tubercle bacilli infect the human body, the former is by far the more predominant, the bovine being practically never found in the adult and, in this country at least, in never more than a small percentage of children. There is apparently no basis for the older assumption that surgical lesions are more likely to be of the bovine type, although, of course, they are predominantly found in the first decade of life, when such infection is more commonly present.

The importance of this question which might, at first glance, seem somewhat academic, is due to its bearing on prevention and control of infection. Attempts to differentiate the human and bovine types of infection clinically by tuberculin tests have never given definite or constant results and it can be stated with a certainty that this method is useless for such a purpose. In our series the results of only 22 bovine Von Pirquet tests are recorded and of these 21 were positive and one negative; however, of the 21 positive, 12 gave also a positive reaction to human tuberculin. Pathologically, no difference in the lesions caused by the two types of bacilli has ever been found.

There are several additional factors other than the question of the type of infection which must be mentioned, but a detailed discussion of

which is beyond the scope of this paper. One of these is the question of when, during the life of the individual, the bacilli get into the body. This is more definite when dealing with lesions in children, as the time element is not so important. The theory that most infections occur in childhood, even when activity is not present until later life, although borne out by certain observations, necessitates our believing that either the human type of bacilli can alone survive long periods of inactivity in the body or else that the bovine type is suppressed and superceded by the human bacilli as adult life is reached. The question of mutation need scarcely be considered.

The source of infection and the various methods by which such infection gets into the body are factors about which our knowledge is not as definite as it might be and there are several problems relative to these questions which still remain to be worked out. Tuberculous cows and tuberculous humans are undoubtedly the primary sources of infection and only by proper control of these can any headway be made in the field of prevention of further infections. The milk of tuberculous cows is known to contain active bacilli, and children who drink such milk are sooner or later going to become infected. This does not mean that active foci immediately make their appearance, but that somewhere in the body, usually in the mesenteric or bronchial lymph glands, a focus, more or less quiescent, can be found which may or may not cause trouble later. The infection enters the body, of course, through the intestinal mucosa, and either directly infects the mesenteric glands or passes into the blood-stream by way of the thoracic duct. Once in the blood-stream the bacilli may be carried to any part of the body, but probably in the majority of such cases they lodge in the trachio-bronchial glands, having passed through the lungs without causing clinical lesions. Children playing around or living in houses where active pulmonary cases are present might easily infect themselves through the same intestinal channels by bacilli which are carried into the mouth by toys or fingers. Infected dust or sputum particles after lodging on the mucous membranes of the upper respiratory tract would be swallowed and also take the same channel. Direct respiratory or pulmonary infection from inspired bacilli also occurs and there is pathological evidence to show that this may be the main portal of entry into the body. Parrot's law and the researches of Küss and Ghon have shown that the lungs of children with trachio-bronchial gland infection will, with practically no exceptions, always reveal a primary focus somewhere in the parenchyma. Frequently the course of the infection through the lung from the primary focus at the periphery to the glands can be clearly traced. These foci are usually quiescent or represented only by scars.

The tonsils can certainly transmit the infection to the cervical or deeper glands without being in themselves diseased, and undoubtedly some of the patients with early cervical adenitis who later develop active tuberculosis were infected in this way. As many tuberculous infections of various parts of the body occur with no apparent source of infection, either human or bovine, the possibility of such factors as flies, articles of food, clothing, dishes, etc., must also be counted among the infecting agents. Direct transmission of the infection from the mother to the foetus, that is, true congenital transmission, can also undoubtedly take place and with the bacilli in the body through this route there is no reason to suppose that bone and joint infection cannot later be a manifestation of such invasion. An interesting fact brought out in our series of cases is that while 24 per cent of them gave a definite history of tuberculosis in the immediate family, a similar series of the same number of cases of infantile paralysis with no tuberculous lesions showed 22 per cent with like histories. That is, the control series came within two per cent of as many positive tuberculous family histories as did the main series under consideration. On the basis of these findings, no great importance can be attached to such a history.

Given tubercle bacilli in the body, how do they reach the various bones and joints in which we later find them? The explanation is probably somewhat as follows:

A blood vessel is broken into by the infection in some primarily infected gland, usually in the bronchial group, and the bacilli are carried by the blood stream to some remote bone or joint. This apparently simple procedure must, however, be discussed more in detail. When a bronchial gland breaks down due to tuberculosis it may rupture into the bronchial tree and cause a direct infection of the lung, a tuberculous pneumonia, or it may open up some vein and discharge the infected material directly into the blood-stream. The causes of this lighting up of the infection in the gland so that it can disseminate the disease are varied, but any condition which lowers the resistance of the person may be responsible. The exanthemata, particularly measles, have long been mentioned as predisposing to surgical tuberculosis, although influenza and other acute infections are also said to play important parts. The cases in the present series are notably free from previous infections, only 18 out of 193, or less than 10 per cent, giving any history of a disease which even remotely seems to be related to the onset of tuberculosis. These 18 cases are divided among influenza (6), tonsillitis (3), acute pulmonary infection, probably tuberculosis (3), pleurisy (2), whooping-cough (1), pneumonia (1), empyema (1), and discharging ears (1).

After the infected material is emptied into the blood-stream there are three main possibilities which must be considered. In the first place, the resistance of the patient may be so great or the relative resistance so great compared to the number or virulence of the bacilli present that nothing further occurs. The infection is either taken care of in the blood itself, or after localizing is so attenuated that no clinical manifestations appear. In the second place we have the other extreme where the infection is so overwhelming that death ensues shortly afterward, due to miliary or meningeal involvement. The third possibility gives us a group into which fall the cases of bone and joint tuberculosis. Here the natural or acquired resistance is high, but a certain number of bacilli, probably bunched together in a particle of debris so that they are not destroyed in the blood as easily as isolated bacteria, lodge in or near some joint and start a localized tuberculosis. Undoubtedly some foci of this character never develop into clinical lesions by themselves but remain dormant until some exciting cause activates them.

We see, then, that patients with bone and joint tuberculosis are really a culled lot whose resistance is high, for otherwise many of them would have succumbed following the first entrance of the infection into the general circulation. We might expect, therefore, that tuberculin tests would be almost uniformly positive, and statements to this effect are made with the qualification that if the first test is negative larger doses of tuberculin will always bring it out. The Von Pirquet test was, unfortunately, the only one used in our series and the results do not show such a high percentage of positive reactions. The findings are recorded in 178 of the cases, and of these only 67 were positive, while 12 were doubtful, and 99 were definitely negative. To these must be added the nine additional cases that were positive to bovine and not to human tuberculin, as mentioned earlier. Therefore, only about 40 per cent of the cases in the series reacted positively to the Von Pirquet test.

The various theories which have been brought forward concerning the localization of tuberculous infection in or around joints are too well known to need more than brief mention here, and probably the theory of Lexer will account for most of the cases, with certain contributory causes, such as trauma, as secondary factors. Lexer's studies of the distribution of the blood vessels in growing bone showed that emboli tend to lodge in or near the epiphysis due to the presence of the end arteries and capillaries in this location, and these studies also show that in addition to this as a factor in osseous tuberculosis, the

rich vascular supply of developing bone accounts in part for its comparatively frequent involvement.

The importance of trauma as a contributory cause is very great, due to its medico-legal aspect. No definite answer can be given to the question of whether or not a certain injury which preceded the onset of a tuberculous joint is connected with that onset, but the histories are so definite in some cases that it is difficult not to believe that there is some very real part played by trauma in the etiology. Sixty-four, or about 33 per cent, of the cases in the present series gave a very definite history of such injury, and eight, or about four per cent, gave a history which was considered questionable. This percentage is larger than in Krause's series of 1156 cases, for the histories of only 23 per cent of them gave any ground for supposing trauma was related to the localizing of the bacilli. Other larger series also give lower percentages, and Whitman shows a combined series of 3539 cases reported in Germany in which only 16.3 per cent gave injury as a direct predisposing cause. Several factors must be considered in this connection, but it seems that most of the cases showing previous injury can be divided into three groups, the relative importance of which is as yet not definitely established. The first of these comprises those cases in which, due to the injury, always slight in character, there is a localized partial stoppage of the blood stream or a small hemorrhage that allows the lodging of the infected embolus or emboli present in the circulation. In the second group we have the cases in which a tuberculous focus was already present but where it was so early or so encapsulated that as yet no symptoms had been noticed, and the injury, by rupturing or stimulating such a focus, had caused activity or local dissemination. The third group comprises those cases in which, on account of an already present but unrecognized tuberculosis, some very slight injury seems severe because of the sensitiveness of the part, and therefore first calls definite attention to the disease. Here the injury cannot be considered in any way connected with the onset or course, being merely incidental.

The presence of other tuberculous lesions in cases with bone and joint tuberculosis is apparently rare and this fact can be easily accounted for if our previous supposition concerning the high resistance of such cases is true. Nine of our cases had signs of pulmonary involvement on admission, not all of them active, however. Five had, or gave a history of having had, cervical adenitis, two had tuberculosis of the eye, and there was one case each of tuberculosis of the kidney and of the peritoneum. Whether or not these conditions were secondary to the surgical tuberculosis cannot be discussed here, although there may be some etiologic factors involved.

The age of onset in the present series corresponds very closely with that usually taught and reported. One hundred and sixty-nine cases, or 87 per cent, were 10 years of age or under when symptoms were first noticed, the average age of onset in the 193 cases being 5.7 years. The earliest onset, so far as could be determined, was in an infant a little over six months of age, and there were several whose symptoms dated from the first two years of life.

The nationality of the cases investigated and the localities from which they were admitted form an interesting study, but this is, of course, only of value in showing conditions as they exist in Minnesota. Of the 205 cases, 57 per cent came from Hennepin, Ramsey, and St. Louis Counties as would be expected, for the largest centers of population are found within their boundaries. Hennepin County with the city of Minneapolis supplied 19 per cent, Ramsey County with the city of St. Paul, 15 per cent, and St. Louis County with the city of Duluth, 23 per cent. One is immediately struck with the fact that the largest percentage comes from the County which, of the three, has the smallest population. Further study, however, shows that these cases come mainly from the Iron Range and from the families of miners, the large majority of whom are foreign born. The living conditions are usually deplorable and this latter factor may, and probably does have an important bearing on the incidence of the disease. The activity of the County nurses must also be considered as a factor in determining the geographical distribution of the cases.

The nationality is definitely recorded in 148 of the cases considered and of these 47, or 31 per cent, are stated to be of American parentage; 26, or 17.5 per cent, were Finns; 14, or about nine per cent, were Norwegian; 11, or 7.4 per cent, were Swedes; and eight, or 5.4 percent were Germans, the rest being divided among 17 different nationalities, six Indians and two Negro patients being included in the series.

Of the 193 cases, 76 or slightly over 39 per cent, were of the female sex, and 117, or about 60 per cent, were males. This is a greater disparity than is usually reported, as most of the larger series show the percentage of males to be between 52 and 57 per cent. Whether greater activity and more frequent exposure to injuries is an underlying factor in this male predominence can only be surmised.

The points discussed or brought out in this paper are not new, but some of them can bear definite and repeated emphasis. Briefly these are:

1. That poor home conditions, insufficient or improper food, lack of fresh air and sunshine, and the presence of unhygenic surroundings in general seem to be as important, if not more important, than tuberculosis in the immediate family, in the etiology of surgical tuberculosis.

2. That patients of the type under discussion have a high resistance to tuberculosis infection; and

3. That tuberculosis lesions elsewhere in the bodies of such patients are comparatively infrequent.

ARTHRODESING OPERATIONS ON THE FEET.

BY EDWIN W. RYERSON, M.D.

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DEFORMITIES and disabilities of the feet, due to infantile paralysis or other causes, have received a great deal of attention from the orthopaedic surgeons for many years. Certain fundamental principles have been developed which are well worth following. The essential aim of this kind of reconstruction surgery is the improvement of the function of the foot. The damage done by the attack of poliomyelitis, or the traumatism to nerves or muscles by war wound or civil injury, has produced a distorted or unstable mechanism upon which the individual must walk with a degree of difficulty corresponding to the degree of disability. In the early days of surgery, little attempt was made to change the shape of the deformed foot. The shoemaker did his best to supply a covering which fitted the foot, but his efforts ended there. The unfortunate patient walked upon the point of the heel, or the ends of the metatarsal bones, or the side of the cuboid bone, with no prospect or possibility of improvement. In later years, tenotomy and forcible correction offered much hope, but little fulfillment, except in the cases of congenital club foot. It soon became evident that simple correction, or even overcorrection, of paralytic talipes never produced a permanent cure of the deformity. Slowly, but surely, the distortions recurred, in spite of the most carefully designed braces and apparatus. Then came the brilliant tendon-transplantations, ingenious and fascinating. It is simple and easy to convert flexors into extensors; abductors in adductors, etc.; they will functionate, they will obey the mind's commands, but they will not prevent or cure deformity in the feet. The most successful results seen in a large number of carefully performed tendon transplantations recently reviewed by the writer were observed in cases where extensive cuneiform osteotomies had been done simultaneously for the relief of bony deformities. By reason of these osteotomies, some of the joints of the foot, usually the medio-tarsal, had been obliterated, and an ankylosis or arthrodesis had resulted. In practically all other instances,

Fig. I. F. M.

FIG. II. F.M.

FIG. III. F. M.

Paralytic equino-valgus. Triple arthrodesis. Peroneus longus transplanted into tibialis anticus. Operation Nov. 1, 1921. The last two pictures were taken March 13th, 1922.

although the tendon transfers were technically successful, deformity had recurred, sometimes in its original form, sometimes in a different form, but always deformity. The causes of this lack of practical success were, in general, due to three main factors. First, lack of power on account of (a) disparity in size between the transplanted muscle and the one which it was desired to replace; (b) adhesions limiting the range of contractility of the transplanted muscle (much less frequent under the later technique of Biesalski and Mayer); (c) mechanical difficulties resulting from change in direction or function, as in transferring a peroneus longus to act as a tibialis anticus, or making a flexor serve as an extensor; also, failure to suture the tendon under exactly the proper amount of tension. Second, the difficulty in securing an exact balance of power when more than one set of motors were paralyzed, as, for example, combined paralysis of tibialis anticus and posticus, or triceps surae and tibialis posticus, etc. When two groups are paralyzed, the problem of reconstruction is usually too complicated for simple tendon transplantation. Third, the fact that the foot is not a rigid lever, but is made up of many joints which are capable of independent motion, whose mobility cannot be controlled completely by the ordinary tendon transplantations. Under the severe strains of locomotion and weight-bearing, these imperfectly controlled joints become distorted, and deformities soon make their appearance. The subastragaloid and mediotarsal joints are the most frequent offenders, followed by the tarsometatarsal joints.

It is a common experience to find that a tendon transplantation which for many months seems to be a brilliant success gradually becomes less and less efficient, and at the end of two or three years is found to be wholly unsatisfactory from its inability to control the lateral deforming influences. The best results of tendon-transplantation seen by the writer have been where the extensor proprius hallucis was made to act as a tibialis anticus, and where the semitendinosus and the long head of the biceps femoris were transplanted forward into the patella. Although the upper extremity is not included in this paper, it should be mentioned that the results of transplantation in the arm and forearm are much more uniformly satisfactory than in the lower extremity.

One of the most disappointing operations has been the attempt to control varus deformity in the foot by the transplantation of the tibialis anticus as a whole, or in part, to the outer border of the foot. This operation at first seems to be successful, but is always followed by a return of the varus, because the medio-tarsal joint is not properly controlled by the muscle insertion, which has been made at a point distal

to this joint. This operation should be abandoned, in favor of a medio-tarsal arthrodesis.

Next in order came the useful and practical operation devised by Royal Whitman, astragalectomy and backward displacement of the foot. It was designed for the relief of calcaneus and calcaneo-valgus deformities, and has unquestionably been the most generally successful method in use at the present time in the treatment of this particular deformity. Many operators, however, have used it in cases of equino-varus, and the results have been almost uniformly unsatisfactory. The reason for this is not difficult to understand. The removal of the astragalus leaves a large gap or defect in the bony continuity of the inner border of the foot, and although the tibia partly fills this gap, it fails to prevent the recurrence of the varus deformity. In the opinion of the writer of this paper, therefore, astragalectomy should not be performed in any cases of varus deformity where it can be avoided. In a very few cases of great severity (usually neglected cases of considerable age), it may be impossible to obtain sufficient correction unless the astragalus be removed and in such cases the operation should be supplemented by the lateral arthrodesis to be later described.

Silk ligaments, and the implantation of tendons into the tibia and fibula to control varus and valgus deformity have not stood the test of time. They have an inherent mechanical defect, in that they act simply as guy ropes from the leg bones, and they do not prevent motion in the subastragaloid and medio-tarsal joints. They often act admirably to check plantar flexion in "drop-foot," but they do not control rotation and lateral deformity. Implantation or tenodesis of the tibialis anticus or the tendo Achillis by Gallie's method is often useful as an adjuvant to other operations.

Careful analysis of the cases studied in the series previously referred to has led to the conclusion that the chief cause of complaint and disability is the development of lateral deformity in the feet. Calcaneus deformity can be relieved by Whitman's operation. Drop-foot can be relieved by braces or by Gallie's tendon implantation. Lateral deformity, varus or valgus, cannot uniformly be relieved by either method. Some one has observed, and correctly observed, that a person with an artificial leg and foot walks much better than most persons with infantile paralysis. One of the chief reasons is that the ankle joint and foot in an artificial leg are capable of motion only in flexion and extension, the most important motions, and the only really necessary motions, in ordinary walking. There are no deformities in the artificial foot, no painful projections of bone, no calluses or bursae, no lateral instabilities,

Fig. I. E. Y.

Fig. II. E. Y.
Silk ligament suspension, 1914

FIG. III. E. Y.

FIG. IV. E. Y.

FIG. V. E. Y.

After triple arthrodesis. 1914

Silk ligament suspension, March, 1914. In 1922 foot began to turn in to varus. Triple arthrodesis performed July 5, 1922. The last three pictures were taken six months after the arthrodesis.

FIG. I. S. O.

FIG. II. S. O.

FIG. III. S. O.

FIG. IV. S. O.

Paralytic equino varus.

Right foot—Steindler stripping of os calcis. Tendo Achillis lengthened. Hoke's remodelling of head of astragalus. Piece of cuboid inserted into astragaloscaphoid joint. Ext. Prop. Hall. inserted into first metatarsal. Calcaneo-cuboid arthrodesis, also subastragaloid.

Left foot—No subastragaloid arthrodesis, otherwise same operation.

Last two pictures taken eight months after operation.

Why should we not, then, so stabilize the tarsus and metatarsus that these lateral deformities and disabilities cannot occur? The astragalus is held with sufficient firmness by the malleoli, in most cases, to prevent lateral motion of this bone. If, now, we fasten all of the other important bones of the foot to the astragalus, we ought to obtain a foot which is incapable of lateral deviation. Gwilym Davis was probably the first operator to see this proposition clearly, and he devised the horizonal section of the foot, cutting through the joint between the astragalus and calcaneus and then forward in a horizontal plane through the head of the astragalus and the upper part of the scaphoid. No bone or cartilage is removed, but the adjoining surfaces of the astragalus and calcaneus are thoroughly dug up and the chips allowed to remain. The soft tissues having been freely detached, and the chisel-gouge having been freely thrust through from one side of the tarsus to the other, a complete horizontal transverse section of the foot, just below the malleoli, has been made. The foot is then forcibly thrust backward about 2 cm., the two incisions sutured, and a plaster of Paris dressing applied with the foot in slight equinus and with no lateral deviation in either direction. This produces an ankylosis of the subastragaloid and the mediotarsal joints, and very effectually checks all lateral distortion which might occur by reason of motion in these particular joints. Davis' operation has apparently been very infrequently used, to judge by the literature, and yet it was brilliantly conceived and is of great practical value. Like Whitman's operation of astragalectomy and backward displacement, it was designed for the deformity of calcaneocavus, but it prevents lateral deformity in a much more certain and satisfactory manner than does Whitman's operation. It also has the advantage of producing no shortening of the total length of the leg from knee to sole. It does not produce so much stability in cases where the astragalus fits loosely between the malleoli, but in such cases the external malleolus can be cut obliquely and bent into closer contact with the astragalus.

There are some cases, however, where well-marked lateral deformity exists beyond the medio-tarsal joint, usually a varus position, rarely a valgus. In such cases, besides fusing the medio-tarsal joint, it is desirable and practicable to cause a fusion of, first, and most important, the joint between the cuboid and the base of the fifth metatarsal bone, and, next, the joints between the scaphoid, the internal cuneiform, and the first metatarsal bones. This operation has been performed by the writer in a small series of cases, and with results which seem to be satisfactory. An interesting fact has been noted in one case, which may prove to be of considerable importance.

A boy of 7½ years was operated upon in 1920 for a rather severe varus with slight equinus. The cartilage was carefully cut away from the astragalo-scaphoid, the calcaneo-cuboid, and the cubo-fifth metatarsal joints, and the subastragaloid joint was curetted and gouged. The foot was kept in a plaster of Paris splint for three months. Examination in January, 1923, showed a stable, straight, and useful foot, with none of the former tendency to varus deformity. There was, however, no fusion whatever in the astragalo-scaphoid joint. This joint was as freely movable as before, except that its lateral excursions could not be carried out on account of a very complete fusion of the bones on the outer side of the foot. The result, then, is practically as satisfactory as if the astragalo-scaphoid joint were also ankylosed, and there is, in addition, slightly more flexibility of the foot. Whether or not this "lateral arthrodesis" will be sufficient to maintain a correct position of the foot in other cases, remains to be seen. The operation is much easier and more accurate than the astragalo-scaphoid arthrodesis, since the two joints are nearly plane surfaces and the cartilage can be cut off with a few strokes of the chisel. It can probably be performed with success in younger children than can the astragalo-scaphoid arthrodesis, because the layers of cartilage are thinner than in the head of the astragalus, at equal ages, and it is therefore easier to obtain approximation and union of the denuded surfaces. The combined operation should always be performed, however, except possibly in cases of severe varus deformity where it is not desirable to shorten the inner border of the foot.

The purpose of this paper is to advance the following proposition:

1. Lateral deformities of the feet, especially those due to paralysis, are the source of considerable disability.

2. They have not been so successfully provided for as have the deformities of calcaneo-cavus and talipes equinus.

3. They can be effectually treated by arthrodesis of the subastragaloid, the medio-tarsal, and the first and fifth tarso-metatarsal joints.

4. No radical operations should be performed until at least two years have elapsed since the acute attack, nor until careful trial has been made of non-operative treatment, such as muscle training and protection of weakened muscles by apparatus. These operations are much more successful in children over 12 years of age than in younger children.

Muscle training has its distinct limitations. It cannot restore life to dead nerve-cells, but it *can* help weak muscles to hypertrophy, and can train some individuals to use weakened muscles to better advantage. When muscle-training has reached its limit, and this limit falls short of the minimum power necessary for successful locomotion or the pre-

Fig. I. R. B.

Fig. II. R. B.

Fig. III. R. B.

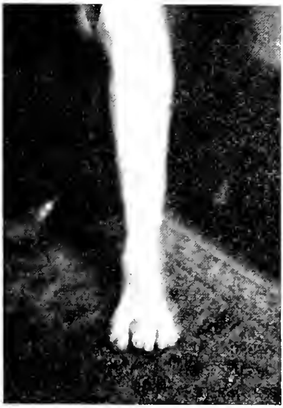

Fig. IV. R. B.

Fig. V. R. B.

Hollow claw foot, with varus. Steindler stripping of os calcis. Wedge from dorsum of foot, including astragalo-scaphoid and calcaneo-cuboid joints. Sub-astragaloid joint curetted. Operation July 7th, 1921. Last three pictures taken Dec. 19, 1921.

vention of deformity, then the patient must choose between operation or a life time of brace-wearing. Even this statement must be qualified, for there are a few unfortunates in every large community who cannot be made to walk either by operation or by braces. Fortunately, these cases are very rare. Braces are unsightly, cumbersome, and annoying, and do not control lateral deformity.

Technique of triple and lateral arthrodesis: the "triple arthrodesis" is indicated where most of the weakness and deformity occur in the subastragaloid and medio-tarsal joints. Mid-tarsal valgus and varus, and the severe hollow claw foot are good examples. The operation is most easily and accurately performed by two incisions, one on the inner and one on the outer side of the foot. A Martin bandage (broad, thin, flat rubber, three inches wide and five or six feet long) is applied from the toes to the knee, the turns barely overlapping each other. It should be wound on snugly, and on reaching the top of the calf just below the knee-joint it should be secured by several turns. The end at the foot is then unwound as far as the knee, and tied or clamped to the upper end. This gives a bloodless field and greatly facilitates the difficult dissection. An incision is now made from just posterior to the inner malleolus, and immediately below it, through the skin only, and carried directly over the astragaloscaphoid articulation and to about the middle of the first metatarsal bone. Below the malleolus the tendon of the tibialis posticus is identified, its sheath is opened, and the tendon is retracted upward. This exposes the joint at the sustentaculum tali, between the astragalus and calcaneum, and further retraction backward will show the posterior part of the substragaloid joint. A narrow chisel, or preferably a Davis flat gouge, can be used to cut loose the articular cartilage, and a very small, strong curette is used to complete the denudation, going as far toward the outer side of the joint as possible.

Next, the astragalo-scaphoid joint is exposed, and opened by cutting the capsule. The attachments of the capsule and ligaments can be peeled away with a chisel, and the cartilage is then cut loose and curetted out. This joint is extensive, and the denudation must be very thorough. In small children, 6 or 7 years of age, the cartilage on the head of the astragalus is nearly one-quarter of an inch thick, and by the time the bleeding bone of the ossification center is reached, there is practically no possibility of bony contact between it and the denuded concave surface of the scaphoid. This is one of the chief reasons for not operating on young children, and is the most frequent cause of non-fusion in this joint. In children of 10 years or more, the cartilage is thinner and the results are proportionately better with each additional year up to 12 or 13. It

FIG. I. R. M.

FIG. II. R. M.

Severe hollow claw feet. Cuneiform osteotomy with sub-astragaloid arthrodesis. July 11, 1922. Also, Steindler stripping of os calcis. These pictures taken seven months after operation.

FIG. I. R. H.

FIG. II. R. H.

FIG. III. R. H.

Operated at $7\frac{1}{2}$ years of age, Feb. 20th, 1920. Triple arthrodesis *right* foot. Astragalo-scaphoid joint did not ankylose, but remains perfectly free. Foot is held perfectly by the calcaneo cuboid fusion. These pictures taken $2\frac{3}{4}$ years after operation. Left foot has never been operated upon

is especially necessary to denude the lateral (outer) aspect of this joint with great care, so that, when the calcaneo-cuboid joint is correspondingly denuded, there will be a complete transverse section through the entire foot, the medio-tarsal joint thus being entirely denuded. If any marked degree of varus or valgus be present, a wedge shaped piece can be removed from the outer or inner section of the medio-tarsal joint sufficient to correct the deformity. If the condition be one of pes cavus or hollow claw foot or calcaneus, the base of the wedge should be upward.

The joints between the scaphoid, internal cuneiform, and base of the first metatarsal can be similarly denuded if deformity beyond the medio-tarsal joint be present or be likely to occur. This part of the operation may not often be required, but should be used especially in severe cases of hollow claw foot.

An incision, similar to the first one, is now made on the outer (lateral) border of the foot, beginning just posterior to and below the external malleolus and extending distally to or beyond the base of the fifth metatarsal bone. The sheath of the peroneus tendons is opened and the tendons displaced and retracted upward, exposing the lateral portion of the subastragaloid joint. This is rather short, and slants upward and backward. It can usually be completely denuded with chisel and small curette, without cutting the external lateral ligamentous structures. The subastragaloid joint, with its two or three subdivisions, is by far the most difficult of all of the joints of the foot to expose and clean out in a proper surgical manner. After this has been done, the calcaneo-cuboid joint is denuded, and made continuous with the astragalo-scaphoid joints, so that the foot is completely mobilized and freed up through the whole extent of the medio-tarsal region. Next, the cubo-metatarsal articulation is attacked and the cartilage cleaned out. The foot as a whole is then viewed as to the complete correction of any pre-existing deformity, and whatever remodelling may be necessary is then done. If, now, there seems to be too great laxness or instability, chromic catgut may be used to bind the bones together, by passing it through drill-holes. This precaution has been very seldom used by the writer, most often, perhaps, in cases of hollow claw foot where a very large wedge has been removed. The wounds are then sutured with interrupted or occasionally-interrupted stitches, after the tourniquet has been removed. The bleeding, very fresh at first, usually becomes inconsiderable after a few minutes, but a few large skin veins may require tying. The work has been largely in the joints and under the periosteum, and the main vessels are not likely to be injured. After suturing, it is wise to insert a few strands of silkworm gut in spaces between sutures, in both outer and inner

Fig. I. E. H.

Fig. II. E. H.

Arthrodesis all tarsal bones on inner side of foot. Ext. Prop. Hallucis transplanted into tibialis anticus. Tendo Achillis lengthened. Operation, March 2, 1921. These pictures taken Nov. 2, 1921

wounds. These drains prevent accumulation of blood in the tissues, and greatly reduce the post-operative pain and swelling. Sterile vaseline is smeared over the wounds, and dressings, folded long and narrow, are placed over the line of sutures. Sterile sheet wadding is wound thickly over the foot and leg, bandaged snugly, and covered with a light layer of plaster of Paris, reinforced on back of leg and bottom of foot with a 2-inch moulded plaster "rope" or splint. If only one foot has been operated upon, it is well to carry the plaster far up on the thigh, with the knee straight, and to suspend the whole leg by straps or frame, as advised by Whitman after astragalectomy. The whole plaster splint should be cut on each side from top to toes, so as to make anterior and posterior halves, and this cut should include the cloth or gauze bandage down to the sheet wadding. If all of these rules be followed, constriction will be avoided and the pain after the operation will be very slight. The cuts in the cast must be made low enough so that when the anterior or dorsal half is lifted off, the two incisions, low down on the two sides of the foot, will be exposed for inspection and dressing, and removal of drains and sutures. The silkworm drains are left in place for 48 hours. It might seem to those who have had no experience with this form of operation that it was unnecessarily extensive, or severe, or dangerous, but this is not the case. The transverse section through the medio-tarsal joint, cuneiform or otherwise, has been done by the writer in a large number of cases, and with the addition of the subastragaloid and other joints in more than fifty. In some of these cases, where the details of drainage and proper splitting of the cast were not carried out, there was severe post-operative pain for several days. In most other instances, there was less pain than after such simpler operations as forcible correction with tenotomies.

The results are extremely satisfactory, so far as observed, and the procedure is recommended as safe and logical. It is believed that it furnishes better stabilization and more central correction than osteotomies in the continuity of the bones. When a partially paralyzed foot has been stabilized in this way, tendon transplantations can be done to provide flexion and extension, with the certainty that disabling lateral deformity will not occur. It is in such cases that transplantation finds its true field of usefulness.

In conclusion, attention may again be directed to the essential instability of the imperfectly controlled medio-tarsal and sub-astragaloid joints as one of the most frequent causes of deformity and disability in paralysis of the leg.

HAMSTRING TRANSPLANTATION FOR QUADRICEPS PARALYSIS.*

BY PAUL C. COLONNA, M.D., NEW YORK, N. Y.

For the purpose of ascertaining the end-results of transplanting one or more hamstrings for loss of function in the quadriceps, due to infantile paralysis, the writer has analyzed the records of 101 cases at the Hospital for Ruptured and Crippled in the five year interval between January 1, 1915 and January 1, 1920, and has personally examined 24 of this group. In this series transplantation of the biceps was done in 78 instances, and the inner hamstrings were transplanted 23 times.

The operator in the majority of the reported series and in 75 of the total number was Dr. Royal Whitman, to whom I am indebted for permission to study these cases. The remaining 26 of the total number were operated on by 13 different surgeons, practically the same technique being employed in all the cases.

The ideal indication for transplanting one or more of the hamstrings is paralysis of the quadriceps extensor alone. Often, however, there is found an associated deformity, such as fixed flexion at the knee, knock-knee, etc., or deformity due to paralysis of one or more muscles of the thigh or leg, which should be corrected if possible before attempting hamstring transplantation.

It has been noted that in walking very little power is needed to extend the leg, as extension is assisted by gravity, and it is only with weight-bearing that the transplanted muscle is called upon to perform its most important duty—that of holding the leg extended. A slight recurvatum at the knee, therefore, may sometimes be desirable, provided the remaining muscles about the posterior portion of the knee-joint are well-developed; otherwise an extreme recurvatum will develop, necessitating the permanent use of a brace. The power of kicking forward, that most of these patients develop following operation, is of value not only in walking, but serves as a mental stimulus for increased effort on the part of patients who never walked without the aid of braces or crutches. Some stabilizing operation on the foot is desirable in many of these cases, and astragalectomy with backward displacement of the foot was satisfactorily employed in 20 of those studied.

*Read at a Clinical Conference of the Hospital for Ruptured and Crippled, January 24, 1923.

Where many individual factors have to be considered for each case the true criterion for the success or failure of an operation such as hamstring transplantation must be considered only in conjunction with other operations necessary for the individual case, and while for convenience the appended chart gives the degrees of extension possible, against the action of gravity, the "Results" are based on the combined necessary treatments received—of which hamstring transplantation was the important but not sole factor. The small size of the transplanted hamstrings in comparison with the powerful quadriceps, as well as the obliquity of the transplanted muscle, makes it evident that full extension is necessarily a rare result, and one that it would be unfair to expect. The fact that the apparently paralyzed quadriceps has a varying return of power following transplantation was well demonstrated in several cases of this series and this doubtless explains many results of "full extension" which have been reported.

The technique employed in this series was as follows: An incision was made on the outer or inner side of the thigh, extending from about the middle of the thigh to a little below the knee. When the biceps was used the tendon of insertion, together with a section of bone or cartilage, was separated from the head of the fibula, care being taken to avoid injuring the peroneal nerve, and dissected back, with the short attachment of the biceps to the femur at a point where the muscle may pull in a direct line from the tuberosity of the ischium to the patella. An incision was then made over the patella exposing the tendon of the quadriceps, the transplanted tendon was drawn through a spacious subcutaneous tunnel, and the bony fragment on the end of the tendon firmly secured under the periosteal covering of the patella by means of karangoo sutures. In a few cases the operator pierced the quadriceps tendon and then inserted the transplanted tendon into the patella, but this apparently was an unessential detail which did not affect the end-result.

The wounds were closed with plain cat-gut, dressings were applied, and the limb was supported by plaster of Paris extending from the toes to the groin, the knee usually being in full extension. The plaster was worn from six to eight weeks, then bivalved, and the strength of the transplanted muscle developed by exercises in bed, retaining the posterior shell as a support. After three or four weeks the patient was encouraged to bear weight on the limb, wearing a supporting brace for several months thereafter.

No.	Name Hist. No. Operator	Age at Polio.	Age at Op	Present Age	Pre-operative Examination
1.	L. S. 11903 B.	1	8	16	Discarded left long brace at three years of age. Paralysis of left quadriceps with foot in equinus. Good power in hamstrings.
2.	Y. O. 12679 W.	2	9	17	Wears double long braces with pelvic band. Falls frequently. Right quadriceps weak but active. Left quadriceps paralyzed but good power in hamstrings. Both feet in attitude of calcaneovalgus.
3.	A. B. 12589 W.	½	13	21	Wears right long brace and short left leg brace. Right lower extremity totally paralyzed. Left quadriceps partially paralyzed, can extend leg about 140°. Good hamstring power on left.
4.	A. C. 12339 W.	2	8	15	Child very fat and walks awkwardly. Wears long brace with pelvic band on right. Paralysis of right ilio-psoas and quadriceps with good power in hamstrings. Right foot in valgus.
5.	H. C. 12326 W.	½	12	19	Only able to walk with aid of crutches. Wore right long brace up to time of astragalectomy, one year ago. Paralysis of right quadriceps with flexion contraction of knee. Hamstrings in good condition. Right foot in attitude of calcaneovalgus.
6.	S. F. 12470 W.	½	7	16	Wears right long brace with pelvic band. Paralysis of the right quadriceps and all the muscles below the knee except the toe flexors.
7.	C. A. 12036 W.	2½	10	18	Patient unable to stand without support. Wears double long spring brace with pelvic band. Contractions at right hip and knee, with paralysis of entire left lower extremity. Right foot in attitude of equinus and "dangle foot" on left. Able to extend right leg to about 115°.
8.	L. O. 12823 W.	½	9	16	Wears right long brace with pelvic band and short left leg brace. All muscles of right lower extremity paralyzed with exception of hamstrings, of which the internal group are the stronger. Both feet in attitude of calcaneovalgus.
9.	C. D 12971 W.	2	8	15	Walks very badly, wearing right long brace. Paralysis of the right quadriceps with right foot in calcaneovalgus. Good power in hamstrings—inner group being stronger.
10.	O. P. 12932 G.	½	7	14	Wears left long brace with quadriceps paralysis and no power below knee on left. Hamstrings weak but active.

Muscle Transplanted	Supplementary Operations	Post-operative Examination	Results
Left biceps	Lengthening T. A.	Patient walks well, wearing no brace. There is slight recurvatum left knee, with outward displacement of patella on extension. Able to extend left leg to 120°.	Good
Left biceps	Bil. astrag.	Patient walks well, wearing no braces. No recurvatum, but moderate degree knock-knee present. Able to extend left leg to 120°.	Excellent
Left biceps	Bil. astrag.	Wears right long brace. No recurvatum. Apparently some return of power in left quadriceps. Able to extend left leg to 170°.	Fair
Right biceps	Ant. displac. of rt. tibialis posticus	Patient overweight. Wears no brace but states he falls occasionally. No recurvatum. Parents state child "greatly improved" since operation. Extends right leg to 150°.	Good
Right semi-memb.	Right astrag.	Walks with aid of crutch, wearing no brace. No recurvatum. Falls occasionally. No extension right leg against gravity but can fully extend when lying on side.	Poor
Right biceps	Right astrag.	Patient walks well with no recurvatum. Able to discard brace one year after transplantation. Definite return of power in quadriceps. Extends right leg to 140°.	Excellent
Right biceps	Left astrag. Tenotomy hip flexors & T. A. Stretchings	Wears left long brace. No recurvatum or outward displacement of patella. Extends right leg to 145°.	Excellent
Right semi-memb.	Bil. astrag.	Wears right long brace. No extension of right leg against gravity. There is a moderate recurvatum of the right knee.	Poor
Right inner group	Right astrag.	Wore right long brace for several years after operation but at present walks without brace. No recurvatum. Able to extend right leg to 140°.	Excellent
Left biceps	Left astrag.	Walks well, wearing no brace. No recurvatum. Able to extend left leg to 100°.	Excellent

No.	Name Hist. No Operator	Age at Polio, Age at Op Present Age			Pre-operative Examination
11.	H. B. 12751 S.	½	10	17	Wears left long brace with pelvic band. Slight contraction of left knee. Left quadriceps paralysis and no power below the knee.
12	R. B.	2	6	13	Wears short left leg brace with paralysis of left quadriceps and no power below the knee. Inner group of hamstrings are stronger.
13.	J. C. 12892 T.	2	5	12	Unable to walk unassisted. Wears right long brace with pelvic band. Slight contraction of right knee. Paralysis of quadriceps and no power below the knee on the right. Good hamstring power though inner group is stronger.
14.	J. G. 13553 R.	5	13	19	Wears long brace with pelvic band on right and short left leg brace on left. Right quadriceps is weak but active. All muscles below knee on left completely paralyzed.
15.	S. B. 12586 W.	2	21	29	Walks with difficulty, wearing left long brace. Paralysis of the left quadriceps and no power below the knee. Inner group of hamstrings are the stronger.
16.	L. S. 12511 W.	1	9	17	Wears left long brace with pelvic band. Patient is very fat and unable to walk without assistance. Paralysis of left hip and thigh muscles except hamstrings. Left foot in valgus. Right knee is hyperextended and there is no power below the knee.
17.	E. F. 13301 W.	2	9	16	Wears left long brace. Paralysis of quadriceps and all muscles below knee on the left. Good hamstring power.
18.	H. L. 13197	3	8	15	Wears right long brace with pelvic band. Moderate contraction of right hip and knee. Paralysis of right quadriceps and no power below the knee.
19.	I. K. 13693 Z.	2	16	22	Wears double long braces with pelvic band. Hip muscles on the right are weak but active. Paralysis of the right quadriceps and foot in equino-varus. Paralysis of the left ilio-psoas and quadriceps. Foot in equino-varus. Good power in both right and left hamstrings.
20.	F. S. 14436 W.	½	5	11	Wears left long brace. There is contraction with slight subluxation of the left knee. Paralysis of the left quadriceps and no power below the knee.
21.	G. V. 12513 W.	2½	11	19	Walks with aid of crutches, dragging left leg and wearing short leg brace on right. Paralysis of left quadriceps and biceps. No power below knee on left.

Muscle Transplanted	Supplementary Operations	Post-operative Examination	Results
Left biceps	Left astrag.	Wears left long brace. Patient states she is "greatly improved." Able to extend left leg to 130°.	Good
Left inner group	Left astrag.	Wears no brace. There is apparently some power in left quadriceps. Able to extend left leg to 155°.	Excellent
Right inner group	Right astrag.	Walks well, wearing no brace. No recurvatum. Able to extend right leg to 160°.	Excellent
Right biceps	Right astrag.	Wears long brace on right but is able to walk without braces. No recurvatum. Able to extend right leg to 120°.	Good
Left inner group	Left astrag.	Wears left long brace but walks well without brace. Able to extend left leg to 150°.	Excellent
Left biceps	No record	Patient is much over-weight. Walks fairly well, wearing left long brace. Slight recurvatum of the left knee. Able to extend left leg to 140°.	Good
Left inner group	Left astrag.	Wears no brace. No recurvatum. Patient states she is able to dance. Able to extend left leg to 100°.	Excellent
Right biceps	Tenotomy of right hip flexors Right astrag.	Wears right long brace but can walk without brace. Right patella is displaced outwards during extension. No recurvatum. Able to extend right leg to 105°.	Fair
Right biceps	Right astrag. Left wedge osteotomy	Wears double long braces but is able to walk without braces. Patient states she is "improved." Able to extend right leg to 140°.	Fair
Left biceps	Left astrag.	Discarded left long brace two years after operation. Falls occasionally. No recurvatum. No extension of left leg against gravity.	Fair
Left inner group	Left astrag.	Walks without crutches, using left long brace and short leg brace on right. Able to extend left leg to 120°.	Good

No.	Name Hist. No. Operator	Age at Polio. Age at Op. Present Age	Pre-operative Examination
22.	J. E. 14869 W.	2 11 16	Wears right long brace with pelvic band. Flexion deformity of right hip and knee. Paralysis of right quadriceps and no power below the knee. Right hamstrings weak but active.
23.	H. W. 14131 W.	2 10 15	Wears double long braces with pelvic band, but unable to walk without the aid of crutches. Paralysis of the right and left quadriceps. Flexion deformity of both hips. Bilateral recurvatum. No power below the knee on either side.
24.			

Careful study of the 24 cases which returned for examination and the records of 77 others seem to warrant the following conclusions:

1. Satisfactory functional results with hamstring transplantation for quadriceps paralysis are the rule rather than the exception.

2. Any accompanying deformity should, if possible, be corrected before transplantation.

3. If sufficient strength exists in the biceps, transplantation of this muscle usually gives better results than those obtained using the inner group of hamstrings.

4. Negative results are apt to follow if the extensors of the hip are also paralyzed.

Muscle Transplanted	Supplementary Operations	Post-operative Examination	Results
Right inner group	Right astrag.	Wears right long brace. Mother states child is "greatly improved by operation." No recurvatum. Able to extend right leg to 110°.	Fair
Right and left biceps	Bil. astrag.	Patient able to attend school and walks without aid of crutches, wearing double long braces. Parents much pleased with improvement. No extension of either leg against gravity.	Good

5. From a physiological standpoint it is interesting to consider how the afferent stimuli, accustomed as they are in initiating the motor response to "flex" can be re-educated and taught to respond to what would appear to be contradictory afferent impulses.

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EXPERIMENTAL INCISION ON THE CADAVER FOR DRAINAGE OF THE ANKLE JOINT.

BY SOLOMON D. DAVID, M.D.

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A SEARCH through available surgical literature on arthrotomy of the ankle joint for the purpose of drainage revealed several methods with radically variable value inherent in each. Usually these incisions are described in the following order: anterior external, posterior external, anterior internal, posterior internal, and the anterior median incisions. Neither specific preference nor differential discrimination are expressed as to any of these incisions relative to the pathological indication, and the operator is left to select any incision of this collection for ankle joint drainage.

In order to ascertain an operative approach to the ankle joint that is reasonably safe, efficacious, and simple for drainage, the writer has carried out a series of experiments on the cadaver with this purpose as his object. These experiments were carried out in the Anatomical Laboratories of the Harvard Medical School, and thanks are due to this institution for making the work feasible.

Since accurate knowledge of anatomy is indispensable for those who essay to do surgery on joints, a word concerning the anatomy of the ankle may not be out of place. The ankle mechanism is a hinge joint, one surface of which is formed by the lower end of the tibia with its internal malleolus, the lower end of the fibula (the external malleolus) and the transverse ligament binding together the tibia and fibula. These structures by their shape form a mortise to receive the dorsal and lateral articular surface of the astragalus as a tenon. Powerful ligaments on the lateral aspects support this complex hinge mortise and tenon.

The deltoid, or the internal lateral ligament, extends from the internal malleolus to the rough edge of the astragalus. From the lateral expansion fasciculi extend to the sustentaculum tali at its mid portion, calcaneal tubercle behind, and to the dorsal astragalo-scaphoid ligament in front.

The external lateral ligament is composed of three portions. The anterior fasciculus extends from the external malleolus to the rough surface of the astragalus immediately above the sinus pedis; the middle

runs to the calcaneal tubercle, and the posterior fasciculus passes almost horizontally to the external tubercle of the talus.

The anterior ligament is membraniform, supported by the tendons passing over it and by a sheet of fat. Its weakness is most manifest in the antero-external aspect.

The posterior ligament is composed of weak, thin, shredlike incomplete membrane extending from the tibia to the astragalus behind. It is strengthened and supported in the postero-medial interval by the tendons of the structures, and in the postero-lateral interval by a thick cushion of adipose tissue. The posterior tibial nerve, artery, and vein lie medial to the flexor longus hallucis in the medial interval.

Several experiments on ankle joints of cadavers were made, each of the five routes of approach to the ankle joints was tested, and the joints were then dissected for further study. The object was, as stated above, to discover an incision safe, easy, and efficient for the evacuation of a purulent effusion of the joint. Glycerine, because of its close resemblance in consistency to that of pus and because of being less diffusible in non-formalin injected material, was used for injection, either through a hole made in the lower end of the tibia or through the anterior ligament. Methylene blue was employed as a coloring substance.

I. ANTERIOR EXTERNAL INCISION.

Through this route the largest amount of the injected fluid was evacuated with the foot in marked plantar flexion. Some of the fluid was found retained in the posterior compartment, created by an imaginary transverse line drawn through the center of the malleoli. With the foot dorsi-flexed, most of the fluid settled in the posterior compartment. This route appears to be good for counter drainage and antero-posterior irrigation.

II. ANTERIOR INTERNAL INCISION.

This is similar to the preceding. Accurate knowledge of the ankle joint is a prerequisite, as the incision might easily enter the sheath of the anterior tibial. There is, however, less room in this region than in the external aspect, and both of these incisions tend to bring the contents of the joint in contact with vital structures.

III. ANTERIOR MEDIAN INCISION.

This incision runs over the neck of the astragalus and the tendons of the extensors of the toes and foot. Upon entering the joint, the foot being plantar flexed, the fluid was found collected in the lateral unsupported portions of the anterior ligament. This is easily explained by the

inherent weakness of these portions. Furthermore, this route seems to be dangerous, deficient, and to possess no particular merit.

IV. POSTERIOR INTERNAL INCISION.

This route brings many important structures into view and invites possible accident. The flexor longus hallucis, hugging the internal portion of the posterior ligament, lies close to the tendo Achillis. Immediately medial to it, the following structures come in order: posterior tibial nerve, vein, artery, vein, flexor digitorum longus, and the posterior tibial muscle.

V. POSTERIOR EXTERNAL INCISION.

This route proved in each experiment to be competent for drainage and safe. It affords ample and easy access. For this incision the foot should be dorsi-flexed, which represents the best functional position for fixation. Every drop of the fluid may be evacuated, provided the foot is placed in the dorsi-flexed position, which position tends to obliterate the anterior compartment and correspondingly to increase the posterior one. With the foot plantar flexed, the anterior compartment retained some of the injected matter. This incision is made in the posterior external aspect of the ankle joint $1\frac{1}{2}$ cm. medial to the tendo Achillis, beginning 5 cm. above the external malleolus and extending down to the os calcis, following the anterior border for $1\frac{1}{2}$ cm. The external saphenous nerve and vein are encountered and retracted posteriorly. A thick pad of fat is seen hugging the posterior ligament. This may be pressed down against the entrance to the subastragaloid joint for protection. The ankle joint is entered above the shining cordlike posterior fasciculus of the external lateral ligament. Incidentally, it may be remarked that this incision affords an excellent approach for drainage of the subastragaloid joint as well.

CONCLUSIONS.

For the purpose of simplicity, the ankle joint may be divided into two compartments by an imaginary line passing transversely through the center of the malleoli. The posterior compartment is formed by the posterior surface of the trochlea, the anterior being formed by the relaxation of the anterior ligament over the neck of the astragalus.

In thirteen experiments on thirteen ankle joints of the cadaver, it seemed to be proved that the posterior external approach was a reliable approach and a safe one, as far as encountering important structures is concerned. The joint cavity is easily accessible by this route, and with the foot dorsi-flexed to a right angle, evacuation of the fluid was complete.

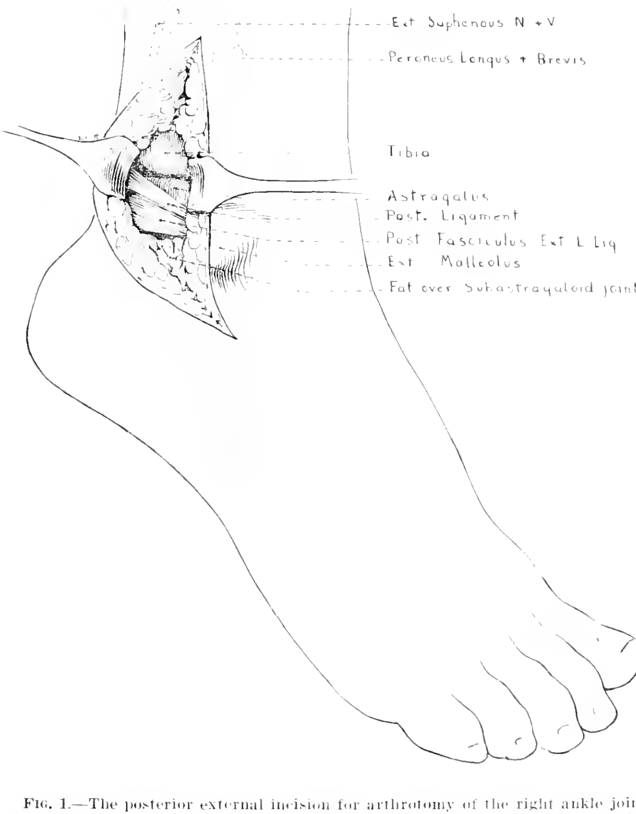

FIG. 1.—The posterior external incision for arthrotomy of the right ankle joint as advocated above. The portion of the posterior ligament is shown by the artist to be more pronounced than it actually is. The shining posterior fasciculus of the external lateral ligament lies immediately below the entrance into the ankle joint and above the calcaneo-astragaloid articulation.

A SURGICAL APPROACH FOR STEP OPERATIONS ON THE FEMUR.

BY ARTHUR KRIDA, M.D., NEW YORK.

An approach to opposite sides of the femur, such as is desirable in step operations for lengthening (or shortening) the femur, must take into account primarily the distribution of the nerve supply to the components of the quadriceps extensor muscle, and minimize as much as possible the amount of direct trauma to the muscle tissue and to the bone. The approach described below conserves muscle tissue and secures an adequate exposure, and by permitting the use of a motor saw, minimizes the trauma to the bone. The procedure was developed on the cadaver.

A curved skin incision is made on the front of the thigh. Beginning in the upper third of the thigh in the midline, it curves externally, then downward, then inward, to a point one inch above and internal to the patella. The skin flap is reflected.

The first incision in the deep fascia is made in the line between the vastus externus and the rectus femoris. Beginning from below, these muscles are separated to a point rather above the middle of the thigh. This exposes the lateral surface of the crureus. The blood vessels and nerve to the vastus externus enter the vastus in the upper angle of separation. The lateral surface of the femur is exposed by an incision through the crureus and periosteum. A saw cut of the required length is made with the motor saw. The saw cut should be sufficiently long to allow of at least a two-inch approximation of the two halves of the step.

The second incision in the deep fascia is made in the line between the vastus internus and the rectus femoris. These muscles are then separated, beginning from below and extending upward as high as the separation on the outer side. This exposes the medial surface of the crureus. The nerve to the crureus enters near the upper angle of the wound and passes downward and outward on the anterior surface of the muscle. The medial surface of the femur is exposed by an incision through the crureus and periosteum, and a saw cut of equal length to the first one and opposite to the same is made. The step is completed by passing a Gigli saw sub-periosteally and sawing from behind at the upper end, and from before at the lower end.

DORSAL WEDGE OPERATION FOR METATARSAL EQUINUS.

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Most orthopaedic surgeons agree that the Whitman operation of astragalectomy with backward displacement of the foot is the most satisfactory procedure to stabilize a dangle foot due to paralysis following anterior poliomyelitis. A great many of these operations have been done at St. Charles Hospital for Crippled Children at Port Jefferson, Long Island, and the patients have in most instances remained in the hospital under constant observation for many months or years. It has been noted that in a small proportion of cases, about six per cent, there has developed equinus of the fore-part of the foot of a degree which has been serious enough to require further operative treatment.

If the Whitman operation has been properly performed, the posterior portion of the foot is in correct relation to the leg and the portion distal to the tarso-metatarsal junction may drop, thus producing a deformity which might be called cavus, but which we have designated as metatarsal equinus, as this term seems to be more descriptive. In cases of complete dangle foot this condition is presumably due to gravity, but in many of the cases grouped with dangle foot there is some power in the short plantar flexors, and therefore there may be some contraction of these muscles causing the deformity. Occasionally at the time of the astragalectomy it has been noted that metatarsal equinus may be expected to result, but in most cases it has not been expected or seen until several months later.

The resulting metatarsal equinus may be slight in degree and require no treatment, but in twenty cases it has been severe enough to interfere with the use of a brace or made it difficult to get the foot in a shoe. The deformity is sometimes fixed, but more often flail in character. In the cases operated upon there has been so much of a drop of the forefoot that the dorsal surface was on the same plane as the anterior surface of the leg.

It was decided that a real and permanent correction could be obtained only by a bony fixation, and in January, 1921, the first case was operated upon. Various minor changes have been made since to facilitate the procedure and various incisions have been used. The present technique

PLATE I.

Case—Right foot after astragalectomy, but before wedge operation, showing extreme metatarsal equinus.
Lower picture shows foot after dorsal wedge operation

PLATE II.

Plaster models of a foot showing inner and outer sides before and after dorsal wedge operation.

of the operation is as follows: A two inch median longitudinal incision through the skin and subcutaneous tissue is made over the dorsum of the foot, with the center over the tarso-metatarsal junction. The deep soft structures are separated by blunt dissection and retracted laterally, exposing the row of tarso-metatarsal joints. A wide osteotome is then inserted, and a wedge of bone with base up and apex down is removed, this wedge including the joints and a portion of the proximal heads of the metatarsals and distal portion of the tarsus. The deformity is then corrected and the gap thereby closed. Two kangaroo tendon sutures through the dorsal periosteum are used to hold the position and keep the space closed. The deep soft structures are then allowed to fall back in place and the skin closed with plain catgut sutures. A sterile dressing is applied and the foot placed in plaster-of-paris to hold the corrected position. After four weeks the plaster is removed and replaced by another for four weeks more and in which walking is permitted.

It is readily seen that the operation is very easy and in a general way is similar to any form of wedge. It is somewhat simplified by the use of a tourniquet at the lower third of the thigh. If there is any varus or valgus present with the equinus, the wedge may be removed with its base somewhat to the outer or inner side of the foot as the case may be, as well as dorsal.

In our series of twenty cases the first operation was performed on January 20, 1921 and the last one on December 5, 1922. The majority of the cases have been watched for some time and the results thus far seem to be permanent and very satisfactory. Eighteen out of twenty are classed as excellent; one of these, however, was re-operated upon as the wedge removed at the first operation was not enough to give full correction. One case is good, but with slight metatarsal equino-varus, and one other case will require operation for varus.

The table below gives the important data on these cases and the illustrations show a typical case before and after the wedge operation and also plaster models of a case before and after.

Number of Operations 20 (on 18 patients).

Foot involved—10 Right. 10 Left.

Sex of patient—7 Female. 13 Male.

Date of paralysis—12 cases in 1916. 8 before 1916.

Date of astragalectomy—Earliest March 27, 1915. Latest Sept. 27, 1921.

Date of Wedge operation—Earliest Jan. 20, 1921. Latest Dec. 5, 1922.

Age at onset—Oldest 7 yrs. Youngest 1 yr. Average 2 yrs., 6 mos.

Age at Astragalectomy—Oldest 13 yrs. Youngest 4 yrs. Average 6 yrs., 4 mos.

Age at Wedge—Oldest 15 yrs. Youngest 6 yrs. Average 9 yrs., 3 mos.

Age at present—Oldest 16 yrs. Youngest 7 yrs. Average 10 yrs., 6 mos.

Interval between paralysis and astragalectomy—Longest 11 yrs. Shortest, 2 yrs. Average 4 yrs.

Interval between astragalectomy and wedge—Longest 6 yrs., 2 mos. Shortest 6 mos. Average 2 yrs., 9 mos.

Interval between wedge and last examination—Longest 2 yrs., 1 mo. Shortest 2 mos. Average 1 yr.

Results—Foot in excellent position and requires no further treatment—18
Foot in fair position but has slight equino-varus—1
Foot in poor position and requires further treatment for varus—1

Walking without apparatus—8.

Walking with braces—11 (because of paralysis higher up).

One case died of pneumonia 5 months after wedge operation but foot was in excellent condition.

CONCLUSIONS.

1. Some dangle feet develop metatarsal equinus after astragalectomy and backward displacement which is severe enough to require further operative treatment.

2. A simple dorsal wedge operation has been done for this condition.

3. The results have been very good to date and 90 per cent of the cases are classed as cured.

A POST-OPERATIVE RETENTIVE APPARATUS FOR TORTICOLLIS CASES

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More or less difficulty has always been experienced in the post-operative retention of torticollis cases, and in the New York Orthopædic Dispensary and Hospital all the usual methods have been tried, with frequently unsatisfactory results. These methods included plaster of Paris, braces, strapping with adhesive plaster, and oblique bed traction.

In an attempt to overcome the faults of all these methods, the following apparatus was devised, and has been in use for almost two years with uniformly excellent results. It overcomes all the disadvantages of the other methods.

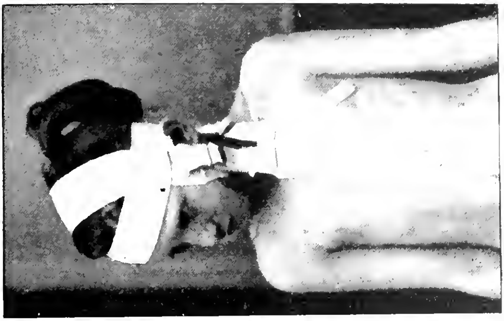
It is really a modification of the old adhesive strapping method, with a very essential difference. Buckles are interposed between the cranial and thoracic portions of the adhesive straps.

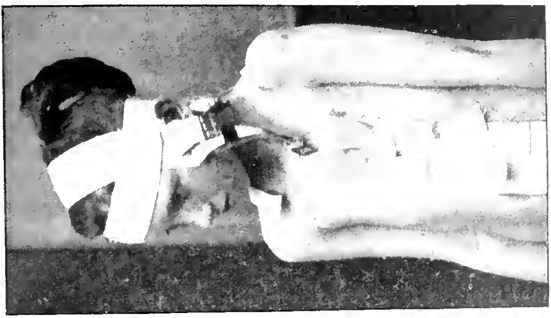
The exact arrangement of the straps and their number vary with the individual case. Usually the arrangement is similar to the illustrations. Three strips of adhesive with straps attached are applied to the head, and either three with buckles attached, or two, one of which carries two buckles, are applied to the trunk extending well down to the pelvis.

These straps are so placed that the head is held in marked over-correction, the chin being rotated toward the affected side, and the head being tilted far over toward the other shoulder.

In cases in which it is undesirable to apply adhesive to the hair, a well-padded plaster cap in which the cranial straps are incorporated may be successfully used. This is seldom necessary, however, as the transverse straps need only to be attached at their ends, and the circular band is at or below the hair margin. In this way but little of the hair is covered by the adhesive.

All the essentials of a retentive apparatus in post-operative care of torticollis are fulfilled by this arrangement. It holds the head in the desired position and is adjustable. It can be released at any time and as often as desired for massage and exercise. It is simple and so comfortable that patients are willing to be up as soon as it is post-operatively desirable.





THE TREATMENT OF CHRONIC BONE ABSCESSES BY SIMPLE EVACUATION THROUGH A SMALL DRILL HOLE. ITS APPLICATION IN NON-STERILE ABSCESSES.

BY WALTER M. BRICKNER, B.S., M.D., F.A.C.S., NEW YORK.

From the Surgical Service of Mount Sinai Hospital

In two earlier publications* I discussed the pathology of chronic bone abscesses, cortical and medullary, and their diagnostic features, and described my method of treating such abscesses, small or large, by mere evacuation through a drill hole.

"The technique of my procedure, as developed, is as follows: Under nitrous oxide narcosis, an incision about 2 inches long is made through the skin and (except, for example, over the inner surface of the tibia) the underlying muscle is split, or retracted, to expose the periosteum. Through this and into the bone, at a point determined by roentgenogram or by the level of maximum tenderness, a drill about one-fourth inch in diameter is driven deep enough to permit the escape of pus. If, perchance, the situation of a small abscess has not been estimated sufficiently accurately for it to be thus tapped by the first opening, other drill holes can be made with little damage to the bone, or the surgeon may defer the completion of the operation to determine roentgenographically the relative levels of the abscess and his first drill hole. With the escape of pus the drill is removed and *nothing else is introduced into the bone*—no probe, curette, or gauze packing! A culture is made from the pus to determine what, if any, living organism it contains. A smear is also stained and examined at once. The purpose of the latter is that if, instead of few or no bacteria, many are found, the surgeon may, if he thinks it desirable, enlarge the bone opening or otherwise modify the procedure. A small drain of folded rubber dam is laid in the soft parts

*Brickner, Walter M.: Chronic medullary abscess of the long bones. Its clinical and roentgenographic features: its treatment by simple trephining. Annals of Surgery, April, 1917 (55, 483).

Chronic bone abscess. Its treatment by simple evacuation through a drill hole. Surgery, Gynecology and Obstetrics, July, 1922 (35, 84).

down to, but not into, the opening in the bone, and the wound is otherwise closed by sutures. A simple gauze dressing completes the operation.

"The drain is to provide for any further escape of pus from the bone, and to act as a safety-valve in case of possible suppuration in the bone cavity or the soft parts caused by dormant organisms awakened to activity. It is removed, usually without replacement, in three or four days, i.e., as soon as discharge has practically ceased. The small opening in the soft parts is then allowed to close and, ordinarily, healing of the entire wound is complete in ten days or less, but few of which, usually, are spent in bed. Contrast this with the prolonged disability and invalidism, not to speak of the scarring and deformity, of wide-open osteotomy and slow "healing from the bottom," with its inherent risks of sequestrum formation and secondary operations!"

The method is based on the conception—the correctness of which has been verified by further observations—that chronic bone abscesses tend

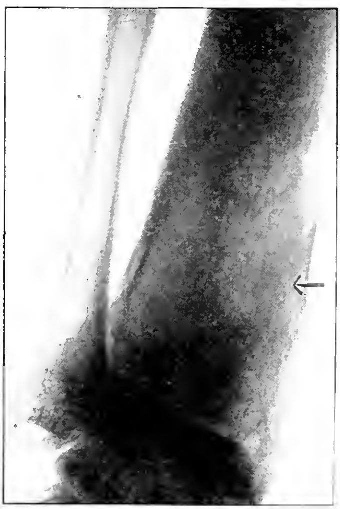


Fig. 1. Abscess in the lower end of the tibia twenty years after acute osteomyelitis. Note that there is very little sclerosis of surrounding bone.

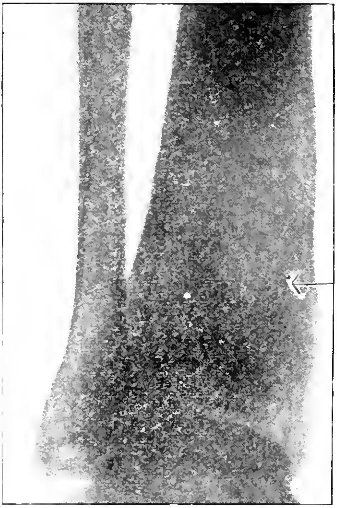


Fig. 2. The same case as Fig. 1, eighteen months after evacuation of the abscess through a small drill hole. Note that the cavity is not entirely obliterated.

to become sterile and afebrile. In my last article, however, I hazarded the suggestion that this procedure might also prove successful in some, at least, of those cases of chronic bone abscess in which clinical signs—daily mild elevation of temperature, slowly increasing pain and tenderness—indicate that the pus is not sterile but that the virulence of the organisms is slight. And I reported therein the case of an abscess in the lower end of a tibia (figures 1 and 2) that had twenty years previously been the seat of an extensive acute osteomyelitis, which abscess was satisfactorily treated by evacuation through a $\frac{1}{8}$-inch drill hole four weeks after its first manifestation of slowly increasing symptoms—pain, tenderness, local heat, and evening elevations of temperature (100.5°-101°). The presence of the staphylococcus (aureus) was determined by both smears and cultures from the pus.

The purpose of the present brief communication is to demonstrate, by further illustrative cases, that complete sterility of the pus is not essential to the success of this method of treating chronic bone abscess.

Fig. 3. Benjamin G. Bilocular abscess in the right tibia, metastatic from chronic suppuration in the left femur, tibia and knee joint. Note that there is almost no condensation of the surrounding bone.

Benjamin G., aged 40, had been under treatment on the services of Drs. Elsberg and Moschcowitz at Mount Sinai Hospital, New York (214074), for over one year for osteomyelitis of the left femur and tibia and pyarthrosis of the left knee. He had undergone numerous operations, the last on November 24, 1922. On December 7, 1922, when his left leg was approaching surgical cure, he complained of pain in the upper inner aspect of the *right* leg. Five days later there was noted a circumscribed, red, tender swelling at about the junction of the upper and middle thirds of the right shin, suggesting a localized bone infection. A roentgenogram on December 14th (figure 3) showed a bilocular abscess in the cortex of the tibia, about 2 cm. x 1.5 cm. in diameters.

On December 19, 1922, under nitrous oxide narcosis, a small incision was made through the skin over the swelling, exposing the slightly thickened periosteum. Through this and the bone cortex was plunged a motor-driven drill of about 3-16-inch diameter, allowing the escape of a few drops of thick pus. With a stout probe the bony septum separating the two portions of the abscess was then broken through and the deeper collection of pus escaped. No drain was inserted, but a wet dressing was applied over the small wound.

Smears of the pus, examined while the patient was still on the table, showed a few Gram-positive cocci; culture developed a pure growth of staphylococcus aureus. At the time of the operation, but also for many weeks before that, the evening temperature had usually been 99.8° or 100°, which might equally have been caused by the process in the left or that in the right leg. After the drilling, however, the highest temperature was 99.4°. The pain was promptly relieved by the evacuation of the pus; the swelling rapidly subsided; and the small wound healed in a few days. When the patient was discharged from the hospital, two months later, with the left leg also almost healed, he had had no recurrence of any sign or symptom in the right leg.

If we assume that the abscess in the right tibia had its inception at the time of the first complaint of pain (12 days before the drilling) then we may regard this, not as a chronic but as a *subacute* abscess, in which, however, the organisms were, for that patient, of a low grade of virulence. The roentgenogram (figure 3) in this case, like those of the case above referred to, shows practically no reaction (condensation) in the bone surrounding the abscess—which also favors a presumption that the process was a recent one. It is, however, quite possible that the staphylococcus had invaded the right tibia some time before and had developed renewed activity at the time that the pain and swelling appeared.

Bertha L., aged 13, was admitted on December 8, 1922 to the service of Dr. Elsberg, Mount Sinai Hospital (225444) from the out-patient department (Dr. Chargin), where she had been under treatment since 1917 for congenital syphilis. In 1917 also she had been operated upon at the hospital for acute osteomyelitis of the left tibia.

Seven weeks before admission pain had appeared abruptly in the right arm, and it continued, worse at night. Swelling appeared about three weeks later and increased slowly. Fever had been noted a few days before admission to the hospital. Although the Wassermann blood reaction had become and remained negative, active specific treatment (by mercury and salvarsan) was continued, without influencing the process in the arm.

While under observation at the hospital there were noted: the somewhat tender, fusiform, rather hard swelling in the lower third of the right arm that is shown in the photograph (figure 4); irregular pupils; opacity of the left lens; shortening ($2\frac{1}{2}''$) and extensive scarring of

Fig. 4. Bertha L. Medullary abscess of the right humerus probably metastatic from an (antecedent) osteomyelitis of the left tibia

Fig. 5. Roentgenogram from the same case as Fig. 1. Accumulation of pus in the medullary cavity, with moderate surrounding ostitis and periostitis. The light circular area is the trephine opening made a few days before the x ray exposure.

the left leg; corresponding scoliosis; negative blood and spinal fluid Wassermann reactions; daily temperature range between 99° and 100°; and the roentgenographic appearance of the right humerus seen in figure 5.

Essentially this roentgenogram is that of a circumscribed osteoperiostitis and, taken with a careful consideration of the history, signs and symptoms as here recorded, it should have led us to a more positive diagnosis. The history of lues, however, confused our judgment and we were in doubt whether we had to deal with a syphilitic, a pyogenic (abscess), or possibly even a neoplastic involvement of the humerus.

Dr. Elsberg accepted my suggestion to explore the bone with a small cranial trephine, both for gross inspection and to secure a specimen for histologic study. This I accordingly did under ether on December 22nd, through an incision on the outer aspect of the arm safely anterior to the musculospiral nerve. The periosteum was found much thickened, but soft, the bone cortex (at the level of trephinage) also much thickened, but otherwise healthy. When the button of periosteum and bone was removed there escaped from the medullary cavity above, an ounce or more of thick pus. Smears made at once showed no organisms. A rubber dam drain was inserted in the wound to, but not into, the bone, and the skin was otherwise reunited with sutures.

After operation the temperature rose for a day to 103° then dropped to 100° and soon to 99°, where it remained. On the fourth day there was no discharge and the drain was then removed without replacement. A week later the wound was entirely closed, the pain and tenderness had ceased and the swelling was much less. The child was kept in the hospital to secure a raised shoe for the left foot, and then discharged (January 8, 1923). Cultures of the pus had developed the staphylococcus aureus. Histologic examination of the bone button showed chronic inflammation of the periosteum, sclerosis of the bone, no spirochaetae.

In this case, too, one may speculate whether the abscess in the humerus had its inception with the pain that began seven weeks before admission to the hospital or whether the infection had been long dormant there—perhaps since 1917.

An abscess in the bone substance (corticalis) usually shows clearly in the roentgenogram, but, as I have previously pointed out, an abscess within the medullary canal usually cannot be recognized as such, roent-

genographically. The x-ray appearance then is that of the associated osteoperiostitis, by which the abscess can be diagnosed only in connection with the clinical signs—pain and tenderness.

While in all of the still rather few cases of bone abscess in which I have employed simple drainage through a small drill hole, immediate relief and early and thus-far permanent healing were secured, I am prepared to believe that this will not always happen. It is quite conceivable that, as the result of introducing a secondary infection or of the awakening into activity of dormant organisms, suppuration may continue and require further operation. Even accepting such a possibility, however, I believe that there is much to be gained and little to be lost by a trial of the simple minor operation which I again present for surgical consideration.

It will be seen that the procedure is curative not merely in chronic, sterile bone abscesses but also in those chronic (and subacute?) bone abscesses in which living organisms are still present but not virulent. The method is not recommended for acute pyogenic bone infection with high fever.

A NEW PORTABLE PLASTER OF PARIS SPICA FRAME.

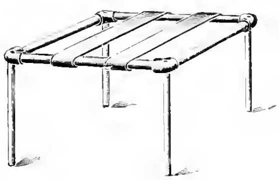
BY LOUIS A. O. GODDU, M.D., BOSTON, MASS.

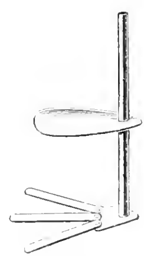
THE following is a description of the writer's handy spica apparatus.

It consists, as the drawing shows, of a back piece that is 9″ by 9″, made of 1/8″ gas pipe. There are four legs which are screwed into each corner, made up of steel 1/2″ in diameter, and 7″ long. The sacral piece is made in parts; the base has an upright, which is screwed on the brace; the sacral parts consist of a large and small size; the upper pin that binds the sacral piece.

This spica can be carried in a small canvas bag, which is 10½″ by 10½″, and ½″ thick, making a portable apparatus that can be carried in an ordinary bag.

It has been exhibited before the Boston Orthopaedic Club, and has been used at the Massachusetts General Hospital. The writer has used it for several years, and feels justified in recommending it as a very handy apparatus for putting on plaster-of-paris spicas. A plaster can be applied easily with a patient in bed, by putting some boards on the bed and setting up the frame, as shown in the cut.





CASE OF OSTEOMYELITIS OF THE ULNA, WITH COMPLETE REGENERATION, IN AN OLD PATIENT.

BY LOUIS A. O. GODDU, M.D., BOSTON, MASS.

The patient was injured Dec. 2, 1921, cutting the back of his right hand, severing some of the tendons. He was attended by a local physician, who sewed up the tendons and skin, leaving a wick in the incision. Three weeks later, patient was going downstairs, slipped and fell, striking his elbow, after which the elbow became swollen, hot, and red. He was again attended by his local physician. This indefinite history is about all I was able to get. The obvious point seemed to be that the man injured his hand, evidently had some sepsis, which apparently cleared up, with infection in the elbow three weeks later.

April 5, 1922, patient was examined at the writer's office. He was a man of 66 years, old for his age, appeared dejected and in exceedingly poor condition. He handled his right forearm very carefully, supporting it with his left hand; all motions were rather painful. Patient's physical examination showed myocarditis, marked arteriosclerosis, and a chronic nephritis; in fact, he presented a poor general condition. Examination of his right arm showed that the middle fingers of the right hand were limited in motion, wrist limited, elbow swollen, tender, hot, with some fluctuation, which extended along the forearm on the dorsal aspect. Elbow could not flex beyond right angle, and extension was limited to within 45° of straight line. X-Rays were advised. These, as can be seen by plate No. 1, showed a marked osteomyelitis of the right ulna, with a slight involvement of the head of the radius. Patient definitely a poor risk.

The problem presented was whether or not amputation or a radical excision of the ulna, which was involved, would offer this patient his best chance. As it was perfectly obvious that the patient could not stand long anaesthesia, and that whatever surgical procedures were resorted to would have to be done rather quickly, it was decided that the patient would perhaps have his best chance with a quick operation, under gas oxygen, for the removal of his entire ulna. This operation was advised.

Operation: April 10, 1922. Patient brought to the operating room, and the writer and his assistant prepared everything for immediate

Plate No. 1. Shows marked osteomyelitis of ulna, with slight involvement of radius.

operative procedures, when patient first showed signs of succumbing to anaesthesia. An incision beginning at the elbow and carried down and directly over the wrist was made; blunt dissector was inserted in the fascia and followed down to the ulna, upward and downward, exposing the entire ulna, which was easily and quickly removed sub-periosteally. Hot saline and handkerchiefs controlled the hemorrhage; wound left wide open, packed with sponges moistened with Dakin's solution; patient back to bed in twenty minutes, and recovery was good.

The subsequent course of the wound was excellent, the filling in of granulations was gradual and progressive. Carrel and Dakin dressings done every day. By June 3rd the wound was practically healed, except a region about the elbow which seemed to be difficult to handle, because of the depth of the wound and rapid progress of the new bone formation. The infection apparently seemed to be resistant and to have involved the new bone in this area.

Plate No. 2. June 2, shows a marked arterio-sclerosis of the vessel, also shows the vessel and new bone formation coming down to portion of ulna left in situ.

On June 12th X-Rays showed a rather interesting situation, in that in the time between April 10th and June 12th an entire new ulna had regenerated, and if observed carefully, it can be seen that the patient developed what apparently is a good olecranon. It might be noticed that because of the loss of the support of the ulna the radius had become dislocated forward. One might argue that this situation could have been prevented by a Thomas splint, with the arm in extension, but it is to be noted that the writer's object was to clear up the infection primarily, because of the drain on the man's system, and the pain and infection, and second to get, if possible, a functioning hand irrespective of a serviceable elbow, which the writer feels he could not have done had he tied up the hand with any form of apparatus to give extension.

It is also to be noted that the writer considered it most important that this man be gotten out of bed as soon as possible, as we know this type of patient very willingly lies in bed and is rather loath to get up,

Plate No. 3. Shows marked regeneration of the whole ulna, the proximal end of which shows some rarifaction and infection, as described in the article.

and at this age and with this amount of disability he was typical of this class of patient. A further consideration is that this man in his debilitated condition would have been an easy prey to hyperstatic pneumonia, and only by constant urging and persisting was the writer able to keep him up and about. The writer did not feel that further operative procedures were indicated as this man was all done as far as being any good as a workman was concerned when he arrived at the writer's office. The object of the entire procedure was to make him more comfortable, which object was apparently accomplished.

The writer still feels that he may be criticised for not amputating, but it would seem to him that amputation would have been a great shock; also this patient did not take kindly to the loss of his right forearm, and probably he was a great deal better off, alive, with a slight discharging sinus, which might heal up, and which, if it did not, was no real trouble to him.

This case is published for the purpose of showing how quickly sometimes the bone will regenerate even in an old person. Furthermore, it seems rather interesting because of several problems which it presented. A brace was given to hold the forearm up at a right angle, and the patient was advised to use the hand as much as possible.

A STUDY OF AUTOPSY SPECIMENS OF FUSED SPINES AND OF CASES SUBJECTED TO SECONDARY OPERATION.*

BY ALAN DE FOREST SMITH, NEW YORK, N. Y.

THE following material from the New York Orthopaedic Hospital and Dispensary is presented as evidence of what occurs in spines operated upon for fusion by the method of Hibbs. It includes a study of ten autopsy specimens from about 600 cases of Pott's disease operated upon between 1912 and 1922. The age of the patients at operation was 18 months to 36 years, and the specimens were obtained at varying periods of from five weeks to three years after operation. In addition to this, a study was made of ten patients in whom a secondary operation afforded an opportunity of examining an area of spine which was fused at a previous operation. They represent all of the cases subjected to secondary operation in a series of 162 consecutive operations for tuberculosis of the spine, and of 59 consecutive operations for scoliosis. The reasons for re-operation were extension of the disease beyond the limits of the previously fused area, renewed activity of the disease, or suspicion that a point of pseudo-arthrosis or failure of fusion existed. The age at first operation in this second series varied from two to twenty-three years, and the period between the first and second operation from one year and one month to five years and seven months.

In nine of the autopsy specimens, the area operated upon shows a continuous column of bone including spinous processes, laminae, and in most cases, lateral articulations. In one case there is an irregular break across the bony column not more than one millimeter in thickness which was occupied in the recent state by fibrous tissue. This represents either a fracture subsequent to fusion, or more probably, a point where there was failure of fusion. It was found in nine of the re-operated cases that fusion was complete. In one, No. 16, a scoliosis case, there was failure of fusion at the apex of the curve.

The percentage of success in the operation cannot be computed from these cases because they represent a certain few in which a return of symptoms, an extension of disease, or in the scoliosis cases, an increase

*Read before the Section on Orthopaedic Surgery of the New York Academy of Medicine, New York City, Dec. 15, 1922.

in the deformity seemed to indicate either an exploration of the operative field or an extension of the fused area. No attempt is made here to present facts which may be used in forming a judgment as to the effect of spine fusion upon the progress of Pott's disease or scoliosis. This may be found in other reports. The purpose is simply to present certain definite observations which may be of use in determining whether or not it is possible to obtain fusion of the spine by such an operation. While the number of autopsies may seem large, it is to be remembered that they are from a series of several hundred cases.

In view of the fact that doubt has been expressed as to the possibility of obtaining fusion of the spine in young children, examination of the specimen No. 1 is of interest. This is a section of spinal column removed at autopsy from a child 18 months old, who died from pneumonia on April 14, 1913, three months after a spine fusion operation performed for Pott's disease. The spinous processes, laminae, and articulations of the first to the sixth dorsal vertebra are fused in a column of bone in which the laminae are all fused together and in which only two adjacent spinous processes have failed to cement firmly. The result is a firm fusion of all six vertebrae operated upon.

The second specimen, that from No. 2, shows a very firm fusion of the twelfth dorsal to the fifth lumbar vertebra inclusive. This patient was operated upon for Pott's disease at the age of 2 years, and died of bronchopneumonia one year and eight months after operation.

The specimen from No. 3 presents a solid plaque of bone extending from the first lumbar to the fifth lumbar vertebra and comprising the spinous processes, laminae, and lateral articulations. This patient was operated upon for tuberculosis of the spine when 4 years of age and died five weeks later from tuberculous meningitis. It is a striking example of the rapidity with which takes place in a child, the consolidation and reconstruction of the elements placed at the disposal of nature by the operation.

No. 4 is that of a boy who was operated upon at 4 years of age for Pott's disease. Spine fusion was performed from the eleventh dorsal to the fourth lumbar vertebra. The patient died two and one-half months after operation. The specimen shows that fusion has taken place between all of the vertebrae and that the remodelling of the bone has proceeded at a remarkable rate. A small knob here and there is all that remains to identify the original spinous processes and bridges of bone between the laminae, the remainder of these structures having been fused into the general column.

One of the second series of cases was first operated upon at the age of 2 years, and four cases at the age of 3 years. These fields of operation were reëxamined at periods of from one year and eight months to four years later. In each case an uninterrupted column of bone was found.

The rapidity of the coalescence of the bony fragments has been mentioned in No. 3. This is the shortest time after operation, five weeks, at which any operated area has been examined. In light of what is known about the process of repair of comminuted fractures elsewhere, however, it is not surprising that fusion should take place in that time. The operation merely creates a condition in which numerous fragments of healthy bone, denuded of soft parts, are placed in contact with each other in an envelope of periosteum.

Although it is not safe to draw general conclusions from a small number of cases, it would seem from a comparison of cases, 1, 3, 4, 9 and 10, that reconstruction of the fragments into a solid column takes place more quickly in children than in adults. In specimen 3, which is from a child 4 years old five weeks after operation, approximately the same stage has been reached as in specimen 9, taken from a man 26 years old four months after operation. The consolidation is much firmer and the reconstruction of the bone fragments much farther advanced in the former than the portion of specimen 10, operated upon two months before death. No. 10 was a man 36 years old. In specimen 1, from an infant 18 months old, three months after operation, the process has gone at least as far as that in the first adult case at the end of two months. A much smoother column with more new bone formation is to be seen in specimen 4, taken from a 4-year-old child, two and one-half months after operation, than in either of the adult cases.

By examining the museum specimens and records of operation at various intervals of from five weeks to five years after the original operation, an interesting picture is had of the various phases in the remodelling of the fragments into a solid smooth column. In the earliest case, the spinous processes and bridges between the laminae are still to be distinguished, but their sharp edges have become lost and the various elements are already fusing into a solid plaque exactly as if they were made of metal and exposed to a high temperature. As the interval after operation increases, the identity of the individual fragments becomes less and less distinct, until finally it is lost in a homogeneous column of bone with a smooth surface. This is thicker in the center where it is formed by the spinous processes. In one specimen this central portion was found to be two centimeters in thickness.

In the earliest specimens the bone is pitted and perforated by numerous minute foraminae and the cortex is thin, but with the increase in the period elapsed after operation, the surface of the bone becomes smoother and harder.

In Case 17, failure of fusion was found at the point where it was suspected from clinical and x-ray examination. Occasionally the x-ray will demonstrate a pseudo-arthrosis, but as a rule it is not to be relied upon. It is sometimes difficult by clinical examination to determine whether or not there is failure of fusion at a certain point. The complete subsidence of symptoms following operation in the tuberculous cases is so constant and striking that any return of pain, muscle spasm and protective attitude, especially if accompanied by an increase in deformity, is considered, *per se*, to be evidence either of failure of fusion or of extension of the disease and therefore an indication for a second operation. The proportionate number of such cases is small.

A majority of the lumbar vertebrae were included in the area of fusion in six of the autopsy cases Nos. 2, 3. 4, 6. 7 and 10, and in two of the re-operated cases, Nos. 13 and 16. These represent patients operated upon at ages ranging from 2 to 36 years. The examinations, either at a second operation or at autopsy, were made at intervals of from five weeks to three years after operation. In all of the postmortem specimens, the lumbar vertebrae were firmly fused together by bone. In one of the re-operated cases there was failure of fusion between the twelfth dorsal and first lumbar and between the first and second lumbar vertebrae. Fusion was solid between the second and third lumbar. In the other re-operated cases all the four lumbar vertebrae which had been operated upon were strongly united by bone. This would seem to indicate that no more difficulty is to be expected in obtaining fusion in the lumbar region than in any other parts of the spine.

CONCLUSIONS.

1. Fusion of the spine may be accomplished by the Hibbs operation in practically all cases. (In a series of 221 operated cases, including both those of scoliosis and tuberculosis, failure of fusion occurred in only one case.)

2. The cause of failure to obtain fusion in the few instances in which it occurs is either inaccurate operative technic in securing bone contact, or infection.

3. There is no difficulty in obtaining fusion in young children.

4. The process of bone repair resulting in fusion proceeds much more rapidly in children than in adults, and therefore children are the most favorable subjects in whom to obtain spine fusion.

5. It is practically impossible to determine by x-ray examination whether or not fusion has occurred as a result of operation in a given area.

6. It is not more difficult to effect fusion in the lumbar region than in other parts of the spine.

AUTOPSY SPECIMENS.

No. 1, J. M., 18 months. Pott's disease. Duration unknown. Slight kyphos from third to sixth dorsal. Operation, January 14, 1913. Spine fusion. Spinous processes of first to seventh dorsal exposed. While the proportion of cartilage on the tips was greater than in older children,

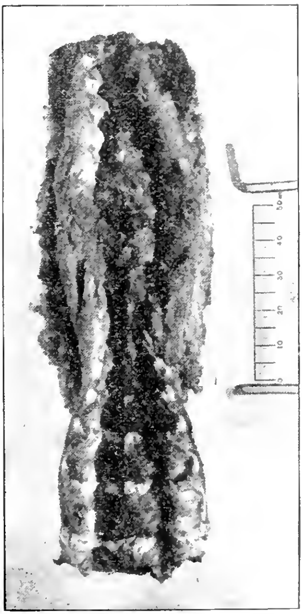


Fig. 1. (Specimen 1.) Fusion of first to sixth dorsal vertebrae in eighteen months old child.

the spinous processes were surprisingly large, being one and three-eighths to one and one-half inches long. Periosteum stripped from spine easily. The first six dorsal spines were fractured in the usual way and laminal chips were loosened and turned down. Wound healed by primary union. April 14, 1913, the patient died of pneumonia, three months after operation. Section of spine operated on was removed at autopsy.

*Gross Pathological Description: The specimen consisted of 14 vertebrae measuring 15 cm. in length. The alignment of the spinal column is destroyed by a dorsal angulation situated six vertebrae from the upper end of the specimen. At the point of angulation the greater part of two vertebrae and the intervertebral disc are gone. The bone bounding the deficiency is roughened and granular where it enters into the boundary of the cavity. The spinal cord is well preserved. In the region of the kyphos, the posterior arches of six vertebrae are fused together. There is firm bone uniting the spinous processes of the first three vertebrae and the last two in this series. (Fusion has not yet occurred between the spinous processes of the third and fourth, but the laminae of all six are united.)

Microscopic Examination: The interspinous ligament extends inward from the tips of the spinous processes about halfway to the root. The site of the inner half of the ligament is bone. New trabeculae of bone extend across from one spinous process to the other, forming a dense mass. The interspinous ligament extending between the tips of the spinous processes is intact. (This was one of the early cases in which the dissection was not performed as thoroughly as it now is.). The roots of the spinous processes facing the cord show bony irregularity along their whole extent. Section from focus of degeneration shows tuberculosis.

No. 2, H. C., 2 years old. Pott's disease. Duration unknown. Marked rigidity of spine. Long rounded kyphos in dorsolumbar region. X-ray shows partial destruction of bodies of second and third lumbar. Operation August 4, 1916. Incision over dorsolumbar region exposing spinous processes of twelfth dorsal to fifth lumbar inclusive. Periosteum dissected away exposing lateral articulations and laminae. Usual laminal bridges and contact between spinous processes made. Discharged from ward December 6, 1916. Admitted to Country Branch, March 23, 1917. December 21, 1917, taken from hospital by parents. April 19,1918, readmitted to hospital. Mass in right iliac fossa. Hyperextension markedly limited in right hip, less marked in left. Patellar reflexes not

*Dr. William C. Clarke of the College of Physicians and Surgeons examined and described the specimen

exaggerated. Kyphos rounded, reaching from tenth dorsal to fifth lumbar with greatest convexity at second lumbar. Fusion seems solid but kyphos has markedly increased. Spine is rigid and any manipulation causes spasm. Posture and gait protective. Profuse nasal discharge. Culture shows streptococci. Developed pustular skin eruption. Streptococci cultured from pus. May 16, 1918, patient died, one year and nine months after operation. Autopsy showed bronchopneumonia.

Specimen is a segment of spine 13 x 4 x 4 cm. including eighth dorsal to fifth lumbar. The first, second and third lumbar bodies have been largely destroyed, producing a posterior angular deformity in this region. The destruction has been more extensive on the right than on the left side, resulting in a cavity between the bodies on the right. The posterior arches of the eighth to the eleventh dorsal inclusive are not changed, but the spinous processes, laminae and articular processes of the twelfth

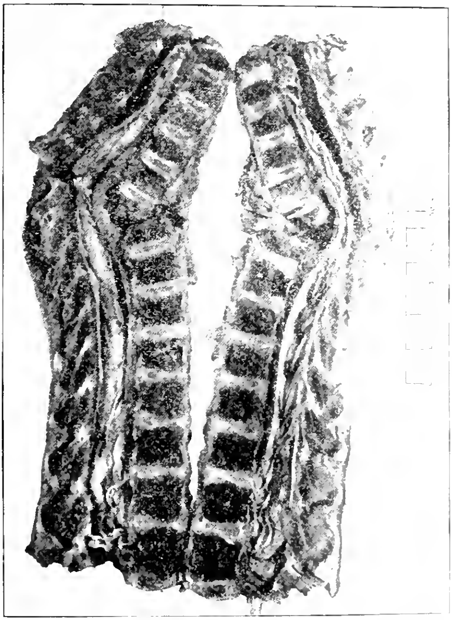


FIG. 2. (Specimen 1.) Vertical section showing area of disease.

dorsal and all the lumbar vertebrae are joined together in a continuous column of bone. At the upper end of this column is a small foramen, but this does not destroy the continuity or appreciably impair the strength of the fused area. The identity of the various elements of the arches has been lost to a large extent.

No. 3, F. S., 4 years. Pott's disease. Duration of symptoms, five months. X-ray shows involvement of bodies of third, fourth and fifth lumbar vertebrae. Operation, November 26, 1920. Subperiosteal dissection from first to fifth lumbar spines. Lateral articulations were curetted, bridges of bone established between laminae, and spinous processes fractured at their bases and contact made. December 31, 1920, died of tuberculous meningitis, five weeks after operation.

Specimen consists of a segment of spine 11 x 5 x 5 cm. comprising the first lumbar to the first sacral vertebra inclusive. The spinous processes, laminae and lateral articulations of the first to and including the fifth lumbar are fused solidly together. The various elements still are

FIG. 3. (Specimen 1.) Low power photomicrograph of vertical section through fused spinous processes.

distinguishable, but the sharp outlines of the spinous processes and laminal bridges have been lost. The remodelling of the bone has progressed to a marked degree. There is evident decrease in the thickness of the disc between the bodies of the third and fourth lumbar and marked thinning of that between the fourth and fifth lumbar. The lower portion of the body of the fifth lumbar on the left side is eroded.

No. 4, S. S., 4 years. Pott's disease. Symptoms first noticed one year before admission. Examined at one hospital and told that there was nothing wrong with spine. Back was then manipulated by a "neuropath". Has had lump on left side for four weeks. Kyphos in upper dorsal region and one in dorsolumbar as well. Entire dorsal and lumbar spine is rigid and muscle spasm is present. There is a mass in left lumbar region and in the left iliac fossa. X-ray shows partial destruction of first and second lumbar vertebrae and possibly a lesion in the upper dorsal and another in the lower lumbar region. Sept. 17, 1915, operation, osteoplastic spine fusion with formation of spinal and laminal bridges from the eleventh dorsal to the fourth lumbar inclusive. Nov.

FIG. 4. (Specimen 1.) Photomicrograph showing new bone trabeculae between spinous processes.

25, 1915, patient became seriously ill with signs of pneumonia in left upper lobe. White blood cells 29,000, polymorphonuclears 93 per cent. Later in the day dullness was found on left side from base to angle of scapula. Aspiration of thorax revealed pus. Culture was sterile. Thoracotomy was performed. Nov. 29, patient died, two and one-half months after operation. Autopsy revealed perforation in diaphragm through which the lumbar abscess had drained into the pleural cavity. There was consolidation of the left lung. Section of spine which had previously been fused was removed.

The specimen consists of segment of spine 10 x 5 x 3.5 cm. including what appears to be the bodies of the twelfth dorsal to fourth lumbar and the posterior arches of the eleventh dorsal to the fourth lumbar. The spinous processes, laminae and articular processes of all the vertebrae are fused together in a single column of bone. The spinous processes and elements of bone uniting the laminae can be distinguished, but to a large extent have been melted into a plaque and there is no sharp boundary between the various parts. There is a perforation about

Fig. 5. (Specimen 1.) Drawing of new bone trabeculae between spinous processes. (Higher power.)

3 cm. in diameter through the lamina of the third lumbar at the right of the spinous processes. The intervertebral cartilages are thin. The disc between the second and third lumbar has disappeared and these bodies have been partially destroyed and have collapsed.

No. 5, K. S., 6 years. Pott's disease, with onset four years before admission. Treated on Bradford frame and has worn braces and plaster jackets until six weeks before admission. Kyphos from first to ninth dorsal with apex at sixth to seventh dorsal. Spine rigid in dorsal region. X-ray shows extensive involvement of the fifth to tenth dorsal inclusive with collapse of the bodies down to and including the ninth dorsal. There is thinning of the disc between the ninth and tenth dorsal. The shadow of an abscess is visible at either side of this area. Within the shadow of the abscess on each side is a smaller, deeper shadow, apparently from a calcified mass. Operation, January 3, 1917, incision from fourth dorsal to first lumbar. Spinous processes exposed and periosteum dissected back from spinous processes and laminae, exposing the lateral articular processes. From the fourth to the twelfth dorsal inclusive, the lateral articulations were curetted. The laminal spurs were turned up instead of down, forming the usual bridge. A green stick fracture was produced in the spinous processes from the fourth dorsal to and including the first lumbar and good contact was made. Wound healed by primary intention. March 23, 1917, patient was transferred to the Country Branch. May 26, 1918, succumbed to tuberculous meningitis, one year and four months after operation. Spine removed from area of fusion.

Specimen consists of segment of spine 16 x 6 x 5 cm. including, apparently, the fourth dorsal to the fourth lumbar. In the upper third of the specimen in the region of the sixth to the tenth dorsal, the vertebrae have collapsed, with the production of a kyphos. In the center of this region the anterior ligament has been dissected away from the vertebrae and stands out prominently as the wall of an abscess beneath which the bone is granular. Posteriorly, the ligaments have been removed from the spinous processes and laminae, revealing a fusion of these elements from the fourth dorsal to the first lumbar inclusive. The spinous processes are still to be distinguished but they have been fused into one solid mass with no definite line of demarcation between the various parts. The lateral articulations are obliterated. The posterior arches of the second and third lumbar are separate and unchanged, not having been included in the area of operation.

No. 6, G. W., 7 years old. Pott's disease. Pain in chest for one year following a fall in 1913. Kyphos formed by twelfth dorsal to third

lumbar spines with apex at first lumbar. Large mass in left iliac fossa. Psoas spasm on left side. Operation, February 14, 1914. Spinous processes fractured and bridges of bone constructed between laminae from ninth dorsal to fifth lumbar inclusive. August, 1914, large fluctuating mass has developed over operative area. This later diminished without interference. Deformity progressed, patient's general condition became poor and she died in 1917, three years after operation.

Specimen is a segment of spine 11 x 5 x 3 cm. from the ninth dorsal to and including the third lumbar vertebra. The elements of the posterior arches of the vertebrae are fused together in a bony column which presents a rounded kyphos, the apex of which is formed by the arches of the twelfth dorsal and first lumbar. The bodies of the ninth and tenth dorsal are discrete and are of normal thickness. That of the eleventh dorsal has collapsed into a wedge, and the bodies of the twelfth dorsal and first lumbar have completely disappeared. Their pedicles have

FIG. 6. Photograph of Specimen 3, showing fusion of lumbar vertebrae in four-year-old child five weeks after operation.

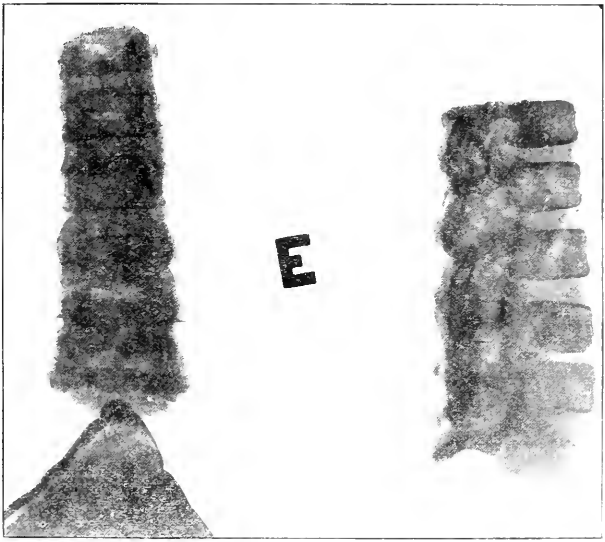


FIG. 7. X-ray of Specimen 3.

united with each other. The body of the second lumbar is represented by a thin plate of bone. That of the third lumbar, although undiminished in thickness, has been invaded by the disease. Across the fused area, between the laminae of the eleventh and twelfth dorsal is a serrated line of fracture, or point at which fusion did not occur. The specimen is thus divided into two parts entirely ununited with each other, the upper consisting of the bodies and fused posterior arches of the ninth to eleventh dorsal, and the lower of the arches of the twelfth dorsal to the third lumbar and the bodies of the second and third lumbar. The anterior surface of the tenth dorsal and the superior surface of the first lumbar bodies, smooth and eburnated, are in contact.

No. 7. *The specimen is a segment of spinal column from a child upon whom a spine fusion operation for Pott's disease was performed. It includes the sixth dorsal to the first sacral vertebrae and is 15 x 5 x 3.5 cm. The vertical alignment of the neural arches is comparatively straight with a deviation of about 1 cm. to the left beginning

at the eleventh dorsal. There is a well marked kyphos with its apex at the twelfth dorsal and first lumbar. From the eighth dorsal to the first sacral the spinous processes and laminae are amalgamated in a single column of bone. Several of the articular processes are fused together, but the majority are not. The ventral portion of the specimen is of particular interest. The bodies in the central portion have been largely destroyed, but the gap between the upper and lower is spanned by a bridge of newly formed bone which extends from the remains of the body of the second to the third lumbar vertebra. There is a sharp offset to the left of the lower lumbar vertebrae, placing them in a different vertical plane from the upper.

No. 8. *The specimen is a segment of spine from the seventh cervical to the third lumbar vertebra inclusive. The bodies of the fourth to the eleventh dorsal inclusive have been largely destroyed and the spine has collapsed in this region with the formation of a sharp kyphos, the apex of which is formed by the seventh and eighth spinous processes. The upper portion of the specimen forms a right angle with the lower. The spinous processes of the fourth to ninth dorsal inclusive, are fused

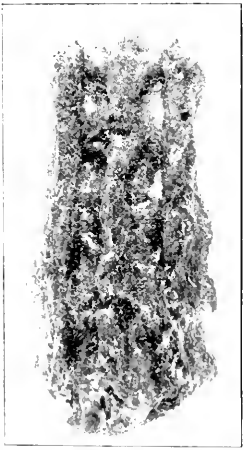


Fig. 8. Photograph of Specimen 4. Firm fusion in four-year-old child, two and one-half months after operation.

*This specimen was removed at autopsy from a child upon whom a spine fusion operation was performed for tuberculosis. The identity of the specimen has been lost.

together and at the apex of the kyphos the laminae also are joined together in a solid mass. (This specimen is from one of the earliest cases, in which the technic was much less thorough than that now employed. An error was made in not including sufficient vertebrae in the fusion.)

No. 9, C. H., 26 years. Pott's disease, duration of symptoms four years. Both legs paralysed for six weeks prior to admission to hospital. Urgency of urination for four months prior to admission, and loss of voluntary control since onset of paralysis. Admitted to hospital January 19, 1922. Small kyphos consisting of the sixth and seventh dorsal spines. Complete motor paralysis of both lower extremities, loss of sensation to pin-point and touch below a line one inch below the costal margin. Excoriations over both buttocks. January 27, 1922, operation for spine fusion. Incision exposing spinous processes of the fifth to the tenth dorsal vertebrae. Laminae and articular processes exposed subperiosteally. The seventh dorsal spine was very prominent and displaced about one-fourth inch posteriorly. Its laminae were wedged tightly against those of the sixth and eighth dorsal. The operation was completed by making laminal bridges, curetting the lateral articulations and turning down the spines after fracturing their bases. No brace was applied because of the tendency to pressure sore. Patient was placed on an air

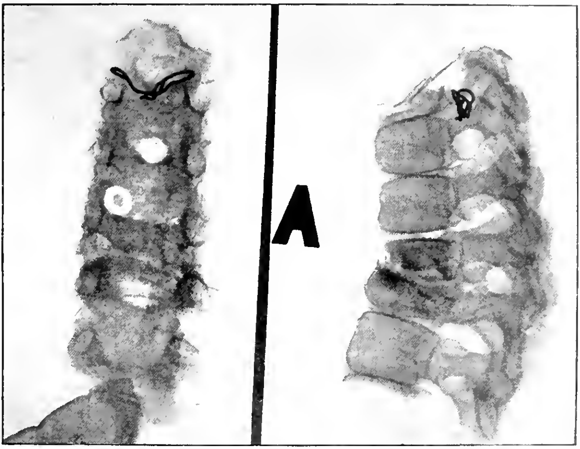


FIG. 9. X-ray of Specimen 4.

bed. In spite of the greatest care, large decubitus ulcers developed on buttocks and patient had high fluctuating temperature for weeks. He died on June 16, 1922, from general sepsis, five months after operation.

The specimen is a segment of spine and cord from the center of the second to the twelfth dorsal vertebra, 22.5 x 6 x 7.5 cm. There is a slight rounded kyphos. From the fifth to the tenth dorsal inclusive, the spinous processes, laminae, and lateral articulations are fused together in a solid bridge. Between the sixth and seventh vertebrae is an irregular crack across the bridge, visible only on forcibly separating the upper and lower parts of the specimen. It is an artefact, having been produced in removing the specimen at postmortem examination. The spinous processes still are distinguishable, but are fused to each other in a strong ridge in the median line, 2 cm. in thickness. The bridges of bone which were turned up and down from the laminae have likewise become melted into a general plaque, but are still distinct. The articulations are represented by knobs of bone, the joint surfaces having been obliterated. The laminae and pedicles of the seventh dorsal are displaced backward. Above and below the area of operation, the elements of the posterior arches are distinct and are movable on each other. The body of the seventh dorsal is almost completely destroyed.

No. 10, D. P., 36 years. Pott's disease. Duration of symptoms four months. Spine rigid. Kyphos from eighth to twelfth dorsal spines with apex at sixth dorsal. Patellar reflexes exaggerated. October 26, 1917, spine fusion from eighth to twelfth dorsal inclusive. May 18, abscess discovered in lumbar region. September, 1918, on flexion of lower spine, there is a sharp pain and muscle spasm suggesting disease below the fused area. There is a discharging sinus from recently drained abscess in lower right lumbar region. X-ray shows disease in twelfth dorsal. Evidently the previous operation, which included only the eleventh dorsal, was not extensive enough to cover the entire diseased area. September 21, 1918, second operation. Fusion extended to include the twelfth dorsal to fourth lumbar. Posterior arches of the tenth and eleventh dorsal vertebrae were exposed and complete fusion of laminae, articulations and spinous processes was found. November 25, 1918, died of miliary tuberculosis, one year and one month after first operation, and two months after second operation. Section of spine was removed at autopsy.

Specimen is a segment of spine 36 x 7 x 7 cm. including parts of the seventh dorsal vertebra and the sacrum and all the intervening portion of the spinal column. There is a dorsal kyphos with the most prominent portion at the tenth and eleventh dorsal and a lumbar lordosis. The

eleventh and twelfth dorsal and first lumbar bodies have been partially destroyed and the intervening fibro-articular cartilages are markedly thinned. Between the eleventh and twelfth dorsal on the left side is a cavity lined with granular bone which apparently communicated with an abscess laterally. Below this and projecting from the left side of the twelfth dorsal and first lumbar bodies is a hard mass about 2.5 cm. in diameter, representing probably a calcified abscess. The disc between the ninth and tenth bodies is thin and the body of the ninth dorsal is diminished in thickness. Posteriorly the spinous process of the seventh dorsal is discrete, but the posterior arches of the eighth dorsal to and including the fourth lumbar are fused together. From the eighth to the eleventh dorsal the fusion is very solid and although the spinous processes and bridges of bone between the laminae can still be recognized as such, they are very indistinct. The bone is quite smooth and the process of remodelling into a homogeneous plaque has gone far. From the twelfth dorsal to the fourth lumbar the column is solid, but the turned down spinous processes and the laminal bridges are still quite distinct and in some cases this amalgamation is not perfectly firm. The articulation between the eleventh and twelfth on the left side has not yet fused, making the column weaker at this point than at any other. The difference between the upper and lower parts of the fused area is due to the fact that the upper was operated upon one year earlier than the lower.

OPERATIVE RECORDS.

Case No. 11, A. C., 2 years and 1 month. Pott's disease. High dorsal kyphos with angular deformity. X-ray shows destruction of bodies of seventh, eighth and ninth dorsal vertebrae. August 23, 1916, spine fusion from fourth dorsal to first lumbar. March 4 1918, general condition poor, kyphos increasing. X-ray shows marked increase in kyphos. Fusion seems good except between fourth and fifth dorsal which now forms the apex of the kyphos. April 16, 1918, second operation, two years and four months after first operation. Incision made from first cervical to seventh dorsal spines. Fusion from fourth to seventh dorsal was complete. Seventh cervical to fourth dorsal included in area of fusion. It was noted that there was marked mobility between second and third dorsal. October 28, 1918, patient died of influenza.

Case No. 12, L. W., 3 years. Pott's disease. Duration of symptoms two months. Kyphos involving the seventh to tenth dorsal. Muscle spasm is present in dorsal and upper lumbar regions. X ray shows marked destruction of the eighth and ninth dorsal bodies, and partial

destruction of the tenth. The seventh and eleventh bodies appear not to be involved. June 5, 1917, operation, spine fusion from the sixth to the twelfth dorsal inclusive. Fusion had occurred naturally between the laminae of the eighth and ninth dorsal. November 26, 1919, posture and gait distinctly protective. Unable to determine whether or not there is a pseudo-arthrosis X-ray shows distinctly the marked increase in kyphos with the center at the ninth dorsal where the disease was most marked in the beginning. When first admitted, involvement was definitely of the eighth, ninth and tenth dorsal. Today the process involves the seventh to twelfth inclusive, with almost complete destruction of all these bodies. Second operation, Nov. 26, 1918, one year and four months after first operation. At operation the old fusion seemed perfect, reaching from the sixth, or possibly the fifth, to the twelfth dorsal. Two vertebrae were added above and below this area. If this fused area bent in forming a greater kyphos, it is the first recognized case. Undoubtedly from the appearance, this is what happened. June 29, 1922, patient is well and free from symptoms.

Case No. 13, S. T., 3 years. Pott's disease. Six months before admission parents noticed hump on back and that legs were becoming weak. There is a slight kyphos with apex at twelfth dorsal and first lumbar. Psoas spasm on both sides. Lumbar lordosis increased. Walks with guarded movement. Left patellar reflex very active. December 2, 1913, operation advised but refused. May 1, 1914, spine fusion performed; subperiosteal dissection from eighth dorsal to fourth lumbar. Spinous processes fractured and bridges made between laminae. October 20, 1916, kyphos appears to have increased. November 10, 1916, exploratory operation, two years and six months after first operation. Region from eighth dorsal to fourth lumbar exposed. Fusion is solid. Spinous processes have been reformed into a smooth column. Patient sent to Country Branch. Discharged cured September 1, 1917. Have been unable to locate him since that time.

Case No. 14, R. G., 3 years. Pott's disease. Kyphos in lower dorsal region. X-ray shows almost complete destruction of ninth dorsal body and partial destruction of eighth and tenth dorsal. January 20, 1915, operation for spine fusion from sixth to twelfth dorsal inclusive. January 16, 1919, patient walks with protective gait and has pain in back. X-ray shows extension of disease above and below fused area. Operation four years after first operation, incision above and below area previously fused. The third to sixth dorsal and twelfth dorsal to third lumbar were added, using the customary technic. Area formerly operated on was

exposed and the vertebrae previously operated upon were found to be solidly united. The spinous processes were welded together, but their outlines could still be made out. January, 1922, no increase in deformity and free from symptoms.

Case No. 15, R. W. K., 3½ years. Pott's disease. Duration of symptoms six months. Slight kyphos from third to sixth dorsal vertebra. Operation December 10, 1913. Spine fusion. Spinous processes and laminae exposed from third to ninth dorsal. Bridges constructed between the laminae. Spinous processes fractured at base and contact established. Symptoms returned in dorsolumbar region in 1916. Second operation May 24, 1916, two years and six months after first operation. Incision made through old scar and extended downward to twelfth dorsal spine. Spinal bridge exposed and found to be completely fused from third to ninth dorsal. The tenth, eleventh and twelfth dorsal were added to the fused area. December, 1917, complains of pain in lumbar region; posture and gait protective. December 18, 1917, third operation. The second lumbar to second sacral vertebrae fused. The area of previous operation from third to twelfth dorsal appears to be completely fused. December 20, discharged relieved.

Case No. 16, D. S., 8 years. Scoliosis following infantile paralysis. December 10, 1919, operation for fusion from fifth dorsal to third lumbar. Spinous processes, laminae and articular processes were united in the fusion. Almost complete fusion in the upper portion of this region was found to exist at the time of operation. January 25, 1921, x-ray shows apparent lack of fusion between the eleventh and twelfth dorsal and between the twelfth dorsal and first lumbar. There appears to be a slight increase in the curve to the left at this point when the patient sits up. Re-operation one year and one month after first operation. Area of former operation exposed and pseudo-arthrosis found between the twelfth dorsal and first lumbar and between the first and second lumbar. Motion was free at these points, but the spine was solidly fused throughout the remainder of the area. Fibrous tissue was removed from the twelfth dorsal and first and second lumbar. Bridges of bone were laid across this area and what remained of the spinous processes was broken down so as to make contact. April 7, 1922, general condition good. Fusion solid with marked curve to the left and with moderate rotation; very slight posterior curve.

Case No. 17, E. D., 11 years. Scoliosis following infantile paralysis. April 2, 1918, spine fusion was performed from second to tenth dorsal inclusive. August 11, 1920, re-operation one year and four months after first operation. There is a marked curve to left with apex at twelfth

dorsal. Area previously operated upon was exposed from the eighth to the tenth dorsal. Spinous processes of the eighth, ninth and tenth dorsal had not been fractured, but the laminae were well fused. Fusion continued to include the third lumbar. April 10, 1922, general condition excellent. Fusion appears to be solid. Posture is very good. General result excellent.

Case No. 18, I. M., 15 years. Patient was operated upon for Pott's disease at the New Jersey Orthopaedic Hospital on February 5, 1916. Spine fusion was performed from the ninth dorsal to the second lumbar by the Hibbs technic. October 13, 1917, patellar reflexes increased. There was marked destruction in lower dorsal region with apex at the ninth and tenth dorsal. November 23, 1917, re-operation, one year and nine months after first operation. Five-inch incision in median line extending upward from the apex of kyphos. Three vertebrae were fused above the area of previous operation. Fusion between the vertebrae previously operated upon was found to be solid. September, 1921, patient died from tuberculous meningitis.

Case No. 19, E. M., 19 years. Pott's disease. Rounded kyphos from third to twelfth dorsal vertebrae. Spine rigid. X-ray shows partial destruction of the eighth dorsal body. July 3, 1916, operation, fusion from the sixth to the tenth dorsal, including the spinous processes, laminae, and lateral articulations. February 7, 1918, upper dorsal region is rigid and attitude protective. No evidence of failure of fusion. There is now a small kyphos with apex at the sixth dorsal just above the sacrum. Second operation one year and seven months after first operation; incision in upper dorsal region, the fourth to the eighth dorsal vertebra being added to the previous field. The eighth, ninth and tenth dorsal were exposed and fusion found to be solid. January, 1921, patient returned to Spain.

Case No. 20, E. L., 23 years. Pott's disease. History of pain in back for one year. Kyphos in lower dorsal region from the eighth to the tenth dorsal. Operation, October 9, 1912. Spinous processes from the ninth dorsal to the second lumbar exposed. Fusion was found to be present between the eleventh and twelfth dorsal and between the first and second lumbar vertebrae. The spinous processes from the ninth dorsal to the second lumbar were fractured at their bases and contact

established between them. May 28, 1918, x-ray shows marked destruction of the eleventh and twelfth dorsal and first lumbar bodies. The ninth and tenth dorsal and probably the eighth, and the second lumbar are also involved. Re-operation five years and seven months after first operation. Incision from the ninth to the twelfth dorsal and from the second to the fifth lumbar. Operation for fusion by the usual technic was done from the ninth to the eleventh dorsal and from the second to the fifth lumbar. Fusion was found to be perfect from the eleventh dorsal to the second lumbar. June 19, 1922, patient is well and free from symptoms.

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FLATTENED HIP SOCKET AND ITS SEQUELAE.

(Coxa Plana, Valga, Vara, and Malum Coxae).

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The femoral head and neck, when being deformed to the condition which was first described by Dr. Legg, pass through the following phases:

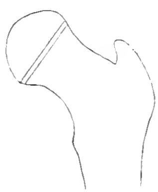


Fig. I
Normal femoral head and neck

Fig. II
Initial stage of coxa plana.

Fig. III

Coxa plana

Fig. IV
Fragmented stage of coxa plana

Starting from the normal condition, represented by Fig. I, the growth-disc is seen to approach the horizontal position (Fig. II). The femoral head and growth-disc rotate, the formation of bone increasing on the medial, decreasing on the lateral side. At the same time a "chin"-shaped protrusion develops on the mesial side at the site of increased bone formation. Moreover, the head often shows a lateral displacement, the lateral border protruding beyond the lateral side of the neck ("head-in-neck"-position). In the growth-disc, which normally lies in an even plane, an irregularity often develops during the rotation and displacement of the head, mostly pointed and directed downwards. All these phenomena precede the more striking symptoms to which the condition owes its name. In other words the rotation of the growth-disc, its lateral displacement, the "chin" and the pointed irregularity in the growth-disc initiate coxa plana, constitute the *initial stage of coxa plana.* (Fig. II.).

Under circumstances which will be studied later on, the deformation of femoral head and neck into coxa plana may come to a stand-still in any stage, also during the development of the initial phenomena. If these circumstances do not present themselves, the flattening of the head, which becomes noticeable even during the initial stage, gradually increases. At the same time it widens out. The neck also widens out, more in its upper than in its lower part. All this is attended by a shortening of the vertical dimension, not only of the femoral head, but also of the neck. During this broadening and flattening (shortening) of head and neck the pointed irregularity in the growth-disc disappears, the growth-disc spreading out in a curved plane parallel with the surface of the head. Coxa plana then has reached the *complete stage.* (Fig. III.).

The form of coxa plana, however, which has been most discussed, exists only when, after progressive flattening of femoral head and neck, the bony part of the head appears to be divided into pieces by translucid areas. The condition might be termed *coxa plana fragmentata* or the *fragmented stage of coxa plana.* Experience has taught that trauma may be helpful in producing the condition, as well as some intercurrent disease, but it may also develop without any traceable cause.

On further growth the bony parts in the femoral head reunite, and in the adult, after ossification of the growth-disc, they form a broad, flat, pear-shaped whole with the femoral neck.

The development of the three stages of coxa plana is restricted to the first ten or twelve years of life. Roughly speaking, the first six years may be said to be spent on the initial stage, the remaining ones on the flattening, widening, and fragmentation. As has been observed, the development of the phenomena may come to a stop in any stage, even in the initial stage. Moreover, the form of *incomplete coxa plana* may undergo certain modifications in after years, but the excessive flattening, shortening, and widening of head and neck and the fragmentation of the head are not seen to develop later on. This fact, too, will have to be taken into account in the explanation of the phenomena

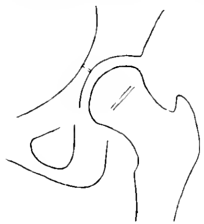


Fig. V
Normal socket
The socket fits round the head. (Socket-line and outline of head run parallel.)

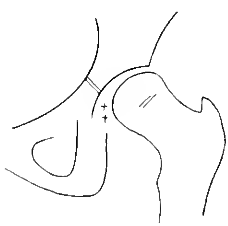


Fig. VI
Flattened Socket
(Through a too thick socket floor)

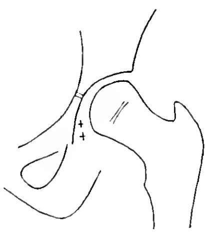


Fig. VII
Widened Socket
(Through ischium varum.)

In flattened socket and in widened socket or shortly: in flattened hip socket the socket does not fit round the normal head. (Socket line and outline of head do not run parallel.) The relation of "cup and saucer" exists: there is a gap ‡. A too thick socket floor implies subluxation (lateroposition) of the femoral head; ischium varum does not.

Certain characteristic changes in the hip-socket, which regularly attend the above phenomena of femoral head and neck, have hitherto escaped the attention of investigators. In all our cases, as well as in those represented in literature which justified a conclusion, we have found either the *floor of the socket too thick, with, therefore, the hip-socket too shallow* (Cf Figs. V. and VI.), or we have found the os ischii running obliquely, its lower end swung mesially, the centre of the hip-socket being the turning point—a condition we have termed *ischium varum*. The lower part of the hip-socket in ischium varum thus appears to have shared the rotating displacement of the ischium. The socket is *too wide*. (Cf Figs. V. and VII.).

Both in the case of a too thick socket-floor and of ischium varum the x-ray plate shows a socket-line with too wide a curve, as if drawn with too large a radius, and the socket may be considered as part of a sphere too large for the femoral head. Both the shallow and the wide socket may be therefore spoken of as *flattened socket*.

Now the flattening of the hip-socket entails considerable alterations in the mechanical relations between femoral head and neck, and in the following pages the development of the phenomena of coxa plana will appear to be the natural outcome of these alterations.

While normally the hip-socket surrounds the femoral head like a close fitting cup, in the flattened socket only small portions are in contact. The condition may be roughly compared with the relation between a cup and a saucer. In the erect posture the femoral head is in contact only with the upper portion of the flattened socket, a gap being left between the mesial part of head and socket. (It is understood that the upper portion of the socket is normal, running practically in a horizontal direction.) The functional stresses which are normally transmitted from the whole of the socket surface to the femoral head, or reversely, are thus concentrated over a small area in the upper part of the socket.

Normally the centre of the femoral head is the fixed point which never moves with regard to the socket, and forms the turning point of all movements. In the flattened socket, however, this is different. The turning point is displaced to the area of contact between head and socket roof, in which, moreover, sliding movements are possible. While normally the functional stresses press the head more firmly against the whole of the socket surface, here the femoral head can be pressed more firmly only against the small area of contact. Now, all stresses which cause a rotation of the femoral head, i. e., those which do not pass

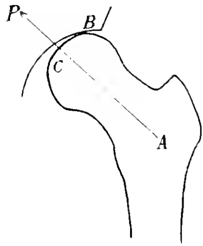


Fig. VIII
All forces (A P) that act upon the femur, and that do not go through the area of contact B, strive to rotate inward and upward the part of the head which is situated mesially to B. (Cf Fig. IX.)

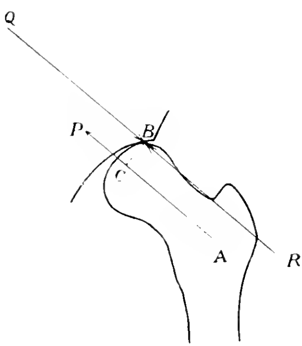


Fig. IX
The muscle forces develop a couple of forces—A P < B C. Moreover, the horizontal component of B R produces a displacement of the femoral head; the vertical component assists the couple in compressing head and neck.

through the area of contact between head and socket, develop a couple of forces which must tend to cause a very characteristic deformation of head and neck.

If in Fig. VIII. AP be the force and B the area of contact between head and socket, the point around which rotation takes place, then $AP \times BC$ is the moment with which AP strives to displace upward and mesially the part of femoral neck and head situated below B.

Suppose instead of the point B a point of the lower part of the femoral head below AP were in contact with the socket. Then the force AP would tend to cause a rotation in a direction opposite to that of Fig. VIII. In the normal socket these rotatory stresses balance one another. In the flattened socket, however, this balance is disturbed, since the contact between the lower part of head and socket is lacking. Hence, in flattened socket only the moment of the force AP of Fig. VIII. can manifest itself.

The action of AP may be determined more precisely, if to Fig. VIII. two equal forces, but opposite in direction, are added, meeting in B and parallel to AP, which, of course, may be done without altering the mechanical condition of the whole. (Cf Fig. IX.) It then appears that besides the couple of forces $= AP \cdot BC$ acting on the femoral head and tending to produce rotatory stresses, a force BR is acting. BR may be separated into a vertical and a transverse component. The horizontal component tends to shove the head mesially; the vertical one simply presses the head against the socket roof.

This reasoning may be applied to all muscular forces which act on some part of the femur, and are directed either below and above B.

Thus the flattened hip-socket alters the mechanism of muscle-function so that three groups of forces must be considered to act on the femoral head and neck:

1° *a couple of forces* which strive to rotate head and neck, moving the mesial part upward, the lateral part downward.
2° *horizontal forces* which tend to cause the head to slide mesially.
3° *vertical forces* passing through the restricted area of contact—exerting a pressure which is reinforced by the power of gravity.
Now, each of these three groups of forces seem to be responsible for part of the phenomena in coxa plana.

It can, indeed, hardly be mere chance that each of the three groups

of phenomena by which coxa plana is characterized corresponds to one of the above groups of forces:

1° the rotation of the head, which leads to the horizontal position of the growth-disc, corresponds to the action of the couple of forces;

2° the lateral displacement of the head corresponds to the horizontal component of the acting forces;

3° the flattening, shortening, and widening out of the femoral head and neck corresponds to the vertical component which acts on the area of contact and is reinforced by the power of gravity.

In a Study "Feebleness of Growth and Congenital Dwarfism," we have tried to prove that, if functional pressure acting on bone tissue exceeds certain limits, decrease of *growth* may result. This decrease is not observed in perfectly normal, unenfeebled children, however much the stresses of function may be increased. But decrease of growth under functional stresses does present itself in children on whom injurious agents have been acting and whose power of growth has thus been enfeebled. This enfeeblement of the power of growth is, as may be understood, proportional, not only to the intensity of the injurious agent, but also to the rapidity of growth (Law of the vulnerability of fast growing cellgroups). Decrease of growth to increase of pressure, therefore, presents itself sooner and more in proportion as the children are younger, and first and mostly in the vicinity of the growth-discs.

In a study "On Bone formation" we have adduced grounds for the assumption that bone, when exposed to functional stresses which exceed a certain limit, will absorb lime-salts and become plastic. This plasticity also presents itself sooner in proportion as the individual has been more enfeebled by injurious agents and it stands to reason that traumatised bone will develop plasticity even through normal weight-bearing when this is applied too early.

Thus in children who have been enfeebled by injurious agents, the functional stresses of muscle action and body weight may retard the growth of bone, and also alter the shape of bones once formed. This occurs soonest and to the greatest degree at times and in areas of rapid growth.[1]

If we compare the initial stage of coxa plana of Fig. II, with the normal femoral head of Fig. I., which are both copies from x-ray plates, by superposing tracings on transparent paper, the circumference of the two appears to differ but little. The head of Fig. II has rotated, it is

(1) For a more complete introduction into the rules of bone-growth and bone-formation, we must refer to the books mentioned.

true, but it is little higher or lower than it should be. The lines of the growth-discs cross. So, on the inner side of the neck where the "chin" has developed, more bone has been formed than normally; on the outer side, where the neck is shortened, the quantity of bone formed lags behind the normal.

In the shallow hip-socket, as well as in the wide, the area of contact between head and socket is situated over the *lateral* part of the growth-disc. So, through this small area the vertical stresses of muscle-action and body-weight are concentrated in addition to those evoked by the couple of forces. The lateral part of the growth-disc in the femoral head, therefore, is made to bear excessive weight. So it cannot cause wonder that there growth is retarded in a way which reminds us of that on the lateral side of knock-knee. The increase of the amount of bone near the mesial part of the growth-disc indicates increased growth in that region through decrease of pressure or—in case of total absence of pressure—possibly also indicates a lengthening of bone once formed under the action of the couple of forces. This lengthening would in the latter case be comparable to the lengthening of the trochanter major in serious cases of coxa vara, when it is made to resist tension stresses exclusively (Cf. "On Boneformation" l.c.).

The degree of enfeeblement of a child (and consequently of its power of growth) necessary to cause the rotation of the head, is surely slight: it is, indeed, observed in individuals in whom there is no question of knock-knees, *i. e.*, in whom the enfeeblement of the power of growth is limited to the muscles and becomes manifest only in flatfeet, prominent abdomen, round back and acrocyanosis and hyperhydrosis. It is well known that the growth-discs near the knee add more to the length of the leg than those near hips and ankle. In a child with normal hip-sockets we accordingly see that decrease of growth to increase of pressure is observed sooner near the knee than elsewhere in the leg. In case of flattened socket, however, there is an exception to this rule, the growth-disc in the neck showing decrease of growth to increase of pressure sooner than the growth-discs near the knee. And this must be accounted for by the fact that all functional stresses are concentrated on a much smaller area, the lateral part of femoral head, growth-disc, and neck.

The question arises whether these stresses may also cause the rotation of the head and growth-disc in perfectly normal, unenfeebled individuals. In perfectly unenfeebled bones, as has been stated in the above, decrease of growth to increase of pressure has not been observed as yet. That is why a certain amount of enfeeblement of the individual

—it may be a slight one—has to be considered a probable condition for the development of coxa plana. The rotation of the femoral head and neck may be considered apart from growth as a simple mechanical occurrence. Growth-disc and adjoining parts then appear in coxa plana as an area of lessened resistance. Needless to say that even this lessened resistance is not observed in normal individuals. Thus we are led to assume that in a perfectly unenfeebled individual all parts of the femoral neck will respond equally to the stresses evoked by the couple of forces, i.e., that the moment of the couple will tend to rotate the whole of the femoral neck laterally, to place it in a valgus position eventually in an upright position. The shortening on the lateral side and lengthening on the mesial side of the neck then will be distributed equally over the whole of the length of the neck. We have indeed observed cases of coxa valga combined with flattened socket (cf. Figs. XXXI., XXXII. and XXXIII. However, we have not yet seen any coxa valga *develop* from the normal femoral neck, and therefore cannot decide in what measure coxa valga has to be considered as a congenital malformation or as one brought about in postnatal life by a primary congenital flattening of the hip-socket. At all events, *it must be deemed possible that flattened hip-socket in unenfeebled individuals may lead to the development of coxa valga.* And the characteristic horizontal position in the growth-disc in coxa valga appears as an initial symptom of coxa plana. Possibly, therefore, coxa plana and certain cases of coxa valga have a common cause in a flattened hip-socket. If so, it is the degree of enfeeblement of the power of growth which in cases of flattened hip-socket may decide whether one or the other condition will develop.

In the following pages we shall try to show that besides the degree of enfeeblement of the power of growth the presence of a primary valgus-position of the femoral neck—it may be slight and within normal limits—lessens the moment of the couple, thus also the chance of a rotation of the head and growth-disc, and with it of the development of coxa plana.

The irregularity of the growth-disc in the initial stage of coxa plana, with the point directed downward, justifies on account of its characteristic form the assumption that it is caused by mechanical stresses, possibly by the couple of forces. At all events, it is seen to disappear in the later stage of flattening and widening of head and neck. Then indeed the enlargement of the area of contact between head and neck not only enhances the resistance against rotation of the growth-disc, but it also lessens the action of the couple which tends to cause this rotation. This may be demonstrated by drawing a line coinciding with

the axis of the femoral neck in Figs. II. and IV. It may then be inferred that a force thus acting in Fig. II. may be able to cause rotation of the head, since it acts outside the area of contact with the socket, whereas in Fig. IV. it will pass through the enlarged area of contact and thus be unable to cause rotation. Be this as it may, this consideration explains why the rotation of the growth-disc in coxa plana stops when femoral head and neck have sustained a certain amount of flattening and widening, viz., mostly at the time when the growth-disc under the evenly flattened head runs parallel to the socket-roof.

That the *horizontal component* of the acting forces tends to cause a lateral displacement of the femoral head need hardly be mentioned. The muscles which produce it are attached to the femur below the head near the trochanters, and every displacement of the head in a mesial direction alongside the socket-roof is bound to evoke shearing stresses in the region of the growth-disc which will tend to displace it laterally.

If the femoral neck could be displaced mesially a long distance, the head might possibly be shoved off the neck altogether. The neck, however, will long before butt against the mesial (i.e. ischio-pubical) portion of the socket with its inner surface, the region of the "chin." And with this mesial contact the mutual co-aptation of the joint-surfaces is introduced. The inner part of the head then is squeezed between the mesial portion of the socket-roof and the femoral neck. It consequently often adopts a pointed shape on that side, different from its round lateral contour, thus adapting itself to its surroundings.

It must be admitted that an injury to the blood-vessels is apt to occur during this displacement of the epiphysis, which is *no novum* in the affections of the femur, as well as during the development of the irregularity in the growth-disc. And the supposition is justified that the relative scarcity of limesalts, which the entire head sometimes shows in the initial stage, may be the result of such vascular lesions. Be this as it may, the displacement of the head constitutes a traumatic factor which may enhance the plasticity of adjacent parts, and create a condition comparable to too early weight-bearing of callus after fracture. And this trauma has to be considered, besides the two above mentioned rules for bone-growth and formation, as the third factor determining the development of coxa plana.

The *vertical component* of the muscle-forces is strengthened by the power of gravity. The femoral neck is simply seen to shorten and widen out like plastic material which is made to bear pressure from above. The distance between the growth-disc and the trochanter major gradually lessens and disappears, while the thickening of the neck causes the fossa trochanterica to rise, so that the trochanter itself becomes smaller

and smaller. It would indeed be difficult to deny in this widening and shortening of the femoral neck and head the activity of the vertical stresses. On the contrary, it seems plausible to consider it the outcome of plasticity of bone under the influence of relatively high pressure.

The broadening of the neck, and therefore also the shortening, first shows itself near the growth-disc. In its transition into the completed form of coxa plana the upper portion of the neck regularly shows more increase in width than the lower portion. The great mechanical changes near the growth-disc thus seem to enhance the plasticity of its surroundings. In agreement with this the region just below the growth-disc often shows the translucid area first described by Waldenström. The plasticity gradually appears to spread. But in every stage of the widening and shortening of the neck the upper region presents more considerable widening than the lower, i.e., the neck appears pear-shaped.

In agreement with the supposition that vascular injuries near the growth-disc contribute to the plasticity of the femoral neck, is the fact that the considerable widening of the neck starts only after the deformation of the growth-disc or also the displacement of the head; as well as the fact that in coxa valga, in which the lateral displacement of the head may be lacking altogether, the deformation is limited to slight flattening and very often to doubtful widening of the neck in the vicinity of the growth-disc (Cf. Figs. XXXI., XXXII. and XXXIII.). However, in coxa valga other factors tend to protect the neck from shortening and widening out, viz., the more equal participation of the convex and the concave-sided bone elements in the neck in bearing the pressure. This point will be dealt with later on. Here it should be emphasized that both the translucency and the plasticity are strongly suggestive of the reaction of traumatised bone to early weight-bearing.

As during the development of coxa plana the femoral neck becomes wider and wider, head and growth-disc are spread out over an ever increasing area. The head thus becomes thinner and adapts itself with the growth-disc to that portion of the socket with which it is in contact. It can cause no wonder that during this ever increasing extension of the head translucid patches, like rents in the bony parts of the head, become visible (*coxa plana fragmentata*). And the connection with mechanical forces makes itself felt in that these rents often present themselves where the plane of the growth-disc shows a bend or curve.

All in all, the study of the x-ray plates of coxa plana presents no phenomenon which is opposed to the assumption that flattened hip-socket is its primary cause. On the contrary, with this assumption all phenomena admit of an explanation according to rules of mechanics, bone-

formation, deformation and growth. Therefore, there is every reason to assume that *flattening of the hip-socket may cause flattening of the femoral head.*

For completeness' sake it must be mentioned that in ischium varum the ischial and pubic bones are not always displaced mesially to the same extent. We meet with conditions in which the x-ray plate justifies the assumption that the os ischii has been rotated mesially more than the os pubis. The x-ray plate then shows the spina ischii on the mesial side of the linea innominata, although the exposure has been symmetrical. In other plates the pubis appears to be relatively more displaced than the ischium. In all these cases the hip-socket is not only too wide or too flat; it is, moreover, *wry*. It stands to reason that, when, for instance, in ischium varum the os pubis shows signs of more mesial displacement than the os ischii, this *twisting* of the socket enhances the incongruence of the articular surfaces and lessens the chance of satisfactory functional co-aptation. The twisted or *wry socket*, however, does not essentially affect the above considerations.

If in the above the explanation of coxa plana has been reduced to that of a congenital malformation of the hip-socket—viz., a widening through ischium varum or also a flattening through a too thick socket-floor—it will now be our task to trace the cause of these congenital malformations.

It is well known that coxa plana is a satellite of congenital dislocation of the hip. It is often observed in the same individual, one hip being dislocated, the other affected by coxa plana; or in the same family, for instance, congenital dislocation of one or both hips in the mother, and coxa plana either on one or on both sides in the child. Coxa plana develops with relatively high frequency after reduction of congenital dislocation. The explanation of ischium varum and a too thick socket-floor will, therefore, at the same time have to lighten up the correlation with congenital dislocation of the hip.

Le Damany has brought forward grounds to assume that the amniotic sac which lags behind in growth after the development of the extremities may flex the hip of the foetus to excess and lever the femoral head out of its socket, the pelvic border acting as a fulcrum, and thus cause congenital dislocation of the hip. If the pressure exerted by the amnion is less intensive, it may be just strong enough to lessen the pressure of the femoral head against the socket-floor, so that the normal deepening of the socket is prevented and a too thick socket-floor results. In other cases the narrow amniotic sac may be drawn too tightly over the ischial bones, and bend them both inward, if the pelvis is lying symmetrically, or deform one of the ischia only, if the pelvis is not lying symmetrically

but lower on that side. Thus flattened hip-socket, either through ischium varum or a too thick socket-floor, may be ranged among the congenital deformities, caused by smallness of the amnion.

Elsewhere we have adduced arguments for the assumption that besides dislocation of the hip other congenital malformations, as achondroplasia, club-foot, etc., may be brought about by smallness of the amnion. It therefore, need not cause wonder that these conditions have been observed with congenital dislocation and coxa plana in the same family and even in the same individual.

Of the causes of smallness of the amnion, little is known. It may probably result from inflammations of the maternal mucous membranes and also from cold. In a large number of cases, however, it presents itself as an hereditary factor with unknown cause. For all that, the above considerations may have the advantage of marking the direction in which both the prevention and the treatment of coxa plana have to be sought.

If in the preceding pages the development of coxa plana has been sketched, it may have become patent that its nature is a diminution resp. the abolition of a congenital incongruence of the articular surfaces. And secondary changes which, moreover, often develop in the socket itself, bear the same stamp. In this light it may be understood:

1 that the development of coxa plana is confined to childhood. The plasticity of bone, indeed, decreases with the rapidity of growth in agreement with established rules;

2 that coxa plana may heal spontaneously, viz., when the congruence of the articular surfaces has been reached;

3 that in case of slight incongruence of the joint surfaces the development of coxa plana may stop in the initial stage;

4 that in case of serious incongruence or of hard bone tissue (i.e., in unenfeebled individuals) the co-aptation of the articular surfaces remain incomplete, and symptoms of joint-wear ("osteo-arthritis") may develop in after-years;

5 that enfeebling influences, for instance, diseases and traumata, promote the development of coxa plana.

A few cases of flattened socket may serve to test and to illustrate the above considerations:

A. Cases *with flattened socket*, i.e., with *a too thick socket-floor;*
B. Cases *with widened socket*, i.e., with *ischium varum.*

A. *Cases with a too thick socket-floor:*

In the first place, Figs. X. and XI., which belong to the rare cases which have been observed both before and during the fragmentation

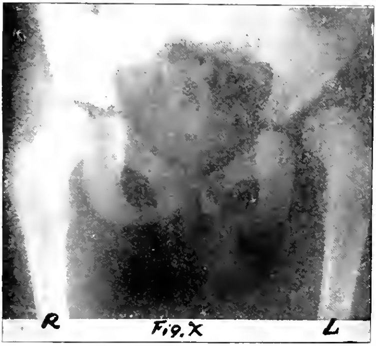
stage.[2] Fig. X., boy, 7 years. The socket-floor is too thick on both sides: the curved line which we will term *socket-line*, is, in its middle—the cartilaginous centre of the socket-floor—too wide apart from the linea innominata. In other words: the strip of cartilage which unites the socket-line and the linea innominata is too long; more even on the left than on the right side. On both sides lateropositio coxae or subluxatio coxae results, the lateral border of the femoral neck being lateral of the lengthening of the lateral border of the os ilii; also more on the left than on the right side. On both sides the femoral neck is too high, the inner border being higher than the lengthening of the upper line of the foramen obturatum. *On the right side the initial stage of coxa plana exists.* (Cf. Fig. II.: the horizontal growth-disc with the irregularity, the "chin" on the mesial side of the neck, the lateral displacement of the head, and the slight flattening.) The outlines of head and socket here run practically parallel, so the co-aptation is rather accurate, and little or no increase of the flattening of the head need be expected in the future. On the left *coxa plana* is present, although in a moderate degree. Mesially and lower down, the distance between head and socket enlarges (Cf. Fig. VI). Both on the right and on the left the femoral neck is widened out, most obviously near the growth-disc.

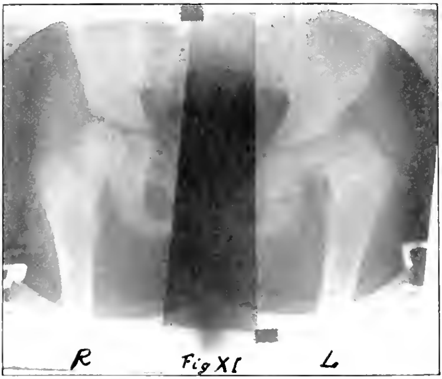
Fig. XI., the same boy, 4½ years later, 11½ years old. The right side has maintained the initial stage of coxa plana. The latero-position exists unaltered. The mesial part of femoral neck and head now seem to transmit the oblique and transverse stresses to the mesial part of the socket; the "chin" more accurately imitates the spherical form of the socket than in Fig. X., and has lost its translucency, its shortage of lime-salts, which is patent in Fig. X. On the *left* side *coxa plana fragmentata* has developed with the excessive widening out of the neck.

If we compare the direction of growth-disc and femoral head of Fig. X. with that of Fig. XI., in the latter the original horizontal position appears to have been lost. To this phenomenon the too thick socket-floor is for obvious reasons more apt to lead than ischium varum. The conclusion seems justified that since the time when the growth-disc assumed the horizontal position the direction of the socket-roof has been modified. A beginning of this change seems to be present even in Fig. X. The action of the couple of forces, indeed, which is obvious in all our other figures, cannot be constructed here.

The flattening of the left femoral head in both figures reaches beyond the bony socket-border. In this the cartilaginous socket-border, as well as abduction movements and mesial displacements of the head along the socket-roof, may have had a share.

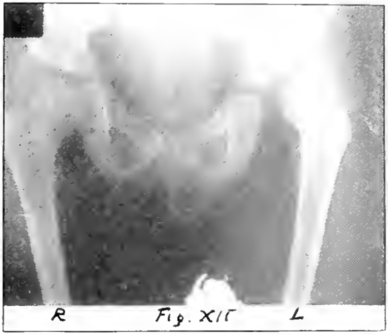
(2) Cordial thanks to Dr. Havinga, who put them at our disposal.

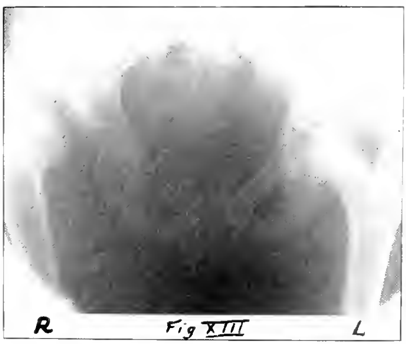




Calot has taught that the upward direction of the socket-roof, the lengthening of the hip-socket in its upper part, has to be considered as the condition for the development of coxa plana. Fig. XI. shows on the contrary that it rather tends to alter the characteristic form of coxa plana, enhancing the chance of an increase of the subluxation and an upward displacement of the femoral head without the characteristic flattening. This may be illustrated by Figs. XII. and XIII.:

Fig. XII., G. S., girl, 4 years, reduced congenital dislocation. Fig.





XIII., H. d. H., girl, 7 years, also reduced congenital dislocation, treated elsewhere. Both show the thickened socket-floor and the sloping socket-roof. The oblique flattening of the head and the thickening of the neck in these cases bear testimony to the amount of stress which presses the femoral head mesially against socket or ilium. They prove that modified mechanical stresses are sufficient to cause flattening of the head and thickening of the neck, i.e., they give evidence of the plasticity of bone under abnormal pressure. The deforming process in the bone tissue here bears the stamp of a co-aptation, and as such it is essentially the same as in coxa plana; only the characteristic shape of Figs. II., III., and IV. is not brought about, because the direction of the stresses is different.

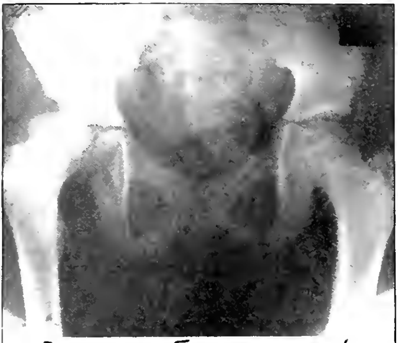


Fig. XIV

Fig. XV

Even those who would assume a bacterial focus acting in these cases would not be able to deny to the pressure against the pelvis a share in the deformation. However, there is no reason for the assumption of a bacterial focus any more than in our other figures. They are all taken from perfectly healthy individuals.

The sloping socket-roof thus yields a contribution to the knowledge of the plasticity of bone under abnormal mechanical stresses and indirectly also to that of the development of coxa plana.

Figs. XIV., P. S., girl, 9½ years; XV., L. d. K., girl, 11 years and XVI., C. S., girl, 9 years, all show the initial stage of coxa plana on the right side (Cf. Fig. II.). Figs. XIV. and XVI., moreover, show shortening and thickening of the femoral neck more obviously than Fig. XV. They are all reduced congenital dislocations with thickened socket-floor and resulting latero-position. They are the perfect likeness of Fig. II., which has passed into the fragmented stage later on.

Note the shortage of limesalts in the region of the "chin," which justifies the supposition that this part of the femoral neck does not yet transmit the stresses from the neck to the socket and reversely.

Fig XVI

The flattened head of Fig. XVI. shows translucid areas. Figs. XIV. and XV. do not show them any more than Fig. X. So they are not constant and therefore have no causal meaning for the development of coxa plana. They may have been produced by irregularities in the acting stresses in connection with irregularities in the articular surfaces or by vascular lesions due to the rotation and displacement of the head, or by both. They are areas of lessened resistance which probably promote fragmentation.

Note that the socket-line on the right side in all three, Figs. XIV., XV. and XVI., as well as the one on the left in Fig. X. in consequence of the too thick socket-floor, describes a wider curve than the corresponding femoral head. The socket-line seems partly stretched. If the completed and the fragmented stage leave some doubt as to whether

the flattening (or widening) of the socket is primary, the widening of the femoral head secondary, *the initial stages of coxa plana show that the widening of the socket is present even before the widening of the head, i.e., that in coxa plana the flattened socket is a primary factor.*

B. Cases with widened socket, i.e., with ischium varum.

Fig. XVII., boy, 7 years, owes the excessive width of his right acetabulum to *ischium varum.* The right os ischii runs obliquely from above and outside down and inward. It has, so to speak, been rotated inward with the centre of the acetabulum as turning point. The lower—ischial and pubic[3]—part of the socket thus has rotated with the ischium with regard to the upper—iliac—part, so the acetabulum appears indented in its cartilaginous centre, a gap being caused between the lower or ischio-pubic part of the socket and the femoral head. This is the gap we consider to be responsible for the development of the couple of functional forces which cause the rotation of head and growth-disc, the displacement of the head and the widening and shortening of femoral head and neck.

Ischium varum has hitherto remained unobserved, because asymmetries in the x-ray plate of the ossa ischii and foramina obturata are involuntarily, almost unconsciously, dismissed by the student, being

(3) The pubic part of the socket line runs—as is well known—in the lengthening of the iliac part. The shadow of the ischial part extends more laterally, and normally partly coincides with that of the femoral head.

attributed to asymmetry in exposure and therefore considered meaningless. Note, therefore, that the varus position of the ischium is present in these as in the following figures, although the other parts of the pelvis show almost perfect symmetry. And especially the greater width of the socket-line on the side of ischium varum, compared with that on the sound side, testifies that the asymmetry is not due to asymmetrical exposure. Nor is it possible to obtain monolateral ischium varum in the x-ray picture with a normal pelvic skeleton. This may be shown by studying the shadow of a skeletal pelvis under the glowing body of a Coolidge tube. It is true, in the normal living body, the whole of the ilium may be displaced in the sacro-iliac joint, and this may be shown in the x-ray plate on very asymmetric exposure, as has been pointed out to us by Dr. Steenhuis, our Leiden röntgenologist, in one of our medical meetings. In that case, however, ilium and ischium have moved together; and the indentation of the acetabulum, th widening or partial stretching of the socket-line, is lacking.

Observe that in Fig. XVII. the os ischii, besides occupying a varus position, is also dwarfed, a fact which does not depend on asymmetry of exposure any more than the varus position, but may also be explained by enhanced amniotic pressure (Cf. "Achondroplasia; its Nature and its Cause").

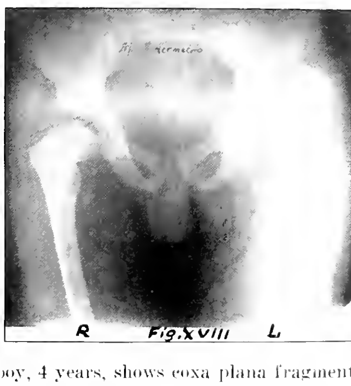


Fig. XVIII., boy, 4 years, shows coxa plana fragmentata on the right side attended by ischium varum.

On the left side the varus position of the ischium is doubtful. The socket-floor is not too thick. In the pubic part of the socket-line, however there is an indentation reaching too far mesially. So the left

socket is probably wry, which may aggravate eventual consequences of the doubtful varus-position of the os ischii. The incongruence on the left side, however, is much less than on the right, and, in connection with this, coxa plana on the left side has not even completed the initial stage.

By the way, we observe that on the side of coxa plana the femoral shaft is regularly thinner and mostly also more translucid than on the normal side. This pleads in favor of the assumption that the functional stresses on that side are always less, and hence the flattening and widening develop notwithstanding the fact that in an absolute sense the stresses of function are less than normally. The bone in which coxa plana is developing, appears to be spared. The rotation of the growth-disc cannot be considered a sufficient reason for any such restricted use any more than f. i. in the developing knock knee. It, therefore, starts probably at the moment when the displacement of the head or the deformation of the growth-disc has made itself felt as a trauma, and changes in the gait become manifest which lead the patient to the doctor.

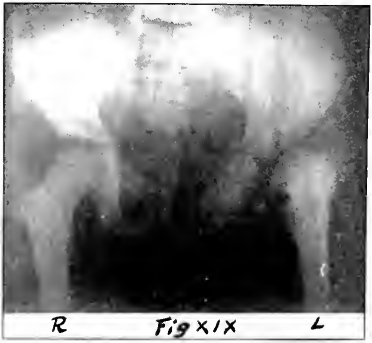
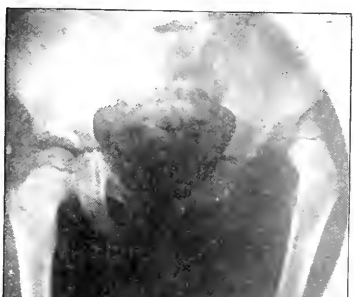


Fig. XIX., M. V., girl, 2½ years, shows left coxa plana which has developed 2½ years after reduction of left congenital dislocation. The left socketline is almost entirely stretched in its pubic portion by a marked ischium varum and nanum. Its upper portion slopes upward in the way described by Calot. The femoral head seems to have absorbed all its limesalts. The form of the flattening of the head departs from the characteristic coxa plana (Cf. Fig. IV.). However, it appears to have been determined by mechanical conditions in this as in other cases, the lines of head and socket running practically parallel. And *this regular coincidence of the form of coxa plana and the direction of the*

mechanical stresses acting upon it, constitutes one of the claims for the assumption of the mechanical cause.

Fig. XX., K. L., boy, 3½ years, and Fig. XXI., H. d. W., girl, 4 years, both show the initial stage of coxa plana on the right side attended by ischium varum.

R Fig XX L



R Fig XXI L

The case of Fig. XX. is the only one of those we represent, that presents reflex-stiffness and a proximation (i.e., flexion-adduction-inward ro-

tation) contracture (of the right hip). It is well known that in the proximation contracture of coxalgia the os ischii may also appear bent backward and inward, so in the x-ray plate the whole of the foramen obturatum may disappear behind the os pubis. This bending of the ischium is probably caused by functional stresses. As is well known, the pelvis, in flexion contractures of the hip, shows increased tilting during walking. The functional stresses, therefore, are not transmitted directly to the sacro-iliac joint, but rather to the ischial spine, so that a couple of forces comes into action, which rotates the ischium upward and inward. In the deformation of ischium and pubis in coxalgia we, therefore, meet with a new example of the plasticity of bone through abnormal pressure.

The possibility is not excluded that in the patient of Fig. XX. the spasm and the proximation contracture of the hip is the cause of ischium varum. However, the x-ray so fully coincides with all other cases in which there is no spasm or contracture whatever, that it cannot alter our views.

The characteristic irregularity of the growth-disc is very marked in Fig. XX. In both figures the head shows a shortage of lime-salts.

In both figures the socket-line obviously departs from the head in its lower portion, so the widened socket appears to exist before coxa plana has developed completely. Thus *ischium varum, as the too thick socket-floor, appears to be a primary factor in the development of coxa plana.*

Ischium varum not infrequently coincides with a too thick socket-floor in the same hip. This cannot arouse wonder if their common cause be considered.

Fig. XXII., boy, about 9 years, and Fig. XXIII., V. K., girl, 8 years, are examples of such coincidence. In Fig. XXII., on the right side ischium varum is more conspicuous than the too thick socket-floor; on the left side, on the contrary, the too thick socket-floor is more conspicuous. The effect is practically the same for either; both socket-lines show a widened curve, are too much stretched, and in their lower portion wider apart from the femoral head than in their upper. Consequently the head is flattened in both hips. Both heads, moreover, show fragmentation. And it should be noted that the latter corresponds to the site of the curve in the growth-disc.

In Fig. XXIII., in which the too thick socket-floor is more conspicuous than the varus-position of the ischium, the widened head laterally projects far beyond the bony socket, as in Fig. XI. A latero-position or sub-luxation exists, the inevitable consequence of a too thick socket-floor.

The above examples chosen from our own observations may suffice. In all our other cases of coxa plana as well as in those of the literature which represent both hips, we found the socket-line too much stretched—either through ischium varum or a too thick socket-floor. We have never met with coxa plana in a normal socket. This proves the intimate

Fig XXII

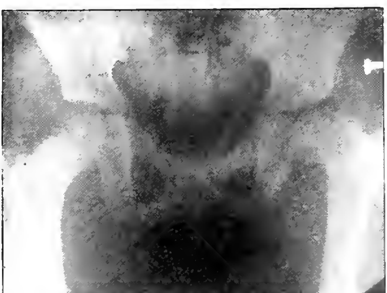


Fig XXIII

relationship between flattened socket and flattened head and has led us to assume that *flattened hip-socket—either through a too thick socket-floor or through ischium varum—is the cause of coxa plana.* And this assumption was confirmed, when it appeared that the effect of the

stresses evoked by flattened socket in femoral head and neck (the couple, the shearing stresses, and the concentrated vertical stresses) perfectly corresponds to what the rules for the growth, formation and deformation of bone with regard to mechanical stresses, which have been established by the study of other skeletal parts, lead us to expect.

In the above we mentioned that flattened socket does not have the same effect on every femoral neck. Three factors here play a role:

(a) *The direction of the femoral neck;*

(b) *The degree of enfeeblement of the individual;*

(c) *The degree of flattening of the socket;*

(d) *Effect of the direction of the femoral neck.*

If the neck is nearer the vertical position than normally, i.e., in coxa valga, the flattening effect of flattened socket is smaller. If, on the contrary, the femoral neck approaches the horizontal position, i.e., in coxa vara, the effect of flattened socket is far more serious than normally.

The following figures may illustrate this:

Fig. XXIV., may represent a normal femoral neck, Fig. XXV. coxa valga, Fig. XXVI. coxa vara. B may be the turning point of the head. If B is supposed to be a fixed point, and perpendicularly above the centre of the femoral head, in all three the couple of forces which we have designated in the previous pages, = AP × BC; BC = BO cos ∟ CBO; and ∟ CBO = the angle which AP makes with the horizontal line.

So in all three the couple of forces is proportional to the cosinus of the angle which the femoral neck makes with the horizontal. Hence, the direction of AP being vertical, the cosinus of the angle being = o, the couple of forces will be reduced to naught; the direction of AP being horizontal, the couple will reach a maximum. And although the mechanical conditions in the real acetabulum will never fully meet the above suppositions, yet it may be assumed that *caeteris paribus, the action of the couple of forces which we have made responsible for the rotation of the femoral head is smaller than normal in coxa valga; greater in coxa vara.*

The effect of the *horizontal component* of BR (Cf also Fig. IX.) is also proportional to the cosinus of the angle which BR makes with the horizontal. Thus with regard to *the shearing stresses* which we have learned to make responsible for the lateral displacement of the femoral head, the same rule holds good, viz., that *caeteris paribus, they are smaller than normal in coxa valga; greater in coxa vara.*

For the *vertical forces* finally which throng through the point of contact B in case of flattened socket, *the mechanical conditions in the femoral neck to resist them are most favorable in coxa valga, most unfavorable*

in coxa vara. It should be remembered that the convex-sided elements (b Fig. XXVII.) normally transmit pressure stresses by which they are preserved and stimulated to bone-formation. In our study "On Boneformation" we have tried to show that *functional pressure* is a stimulus for bone-formation, whereas tension stresses lack the power of promoting bone-formation.

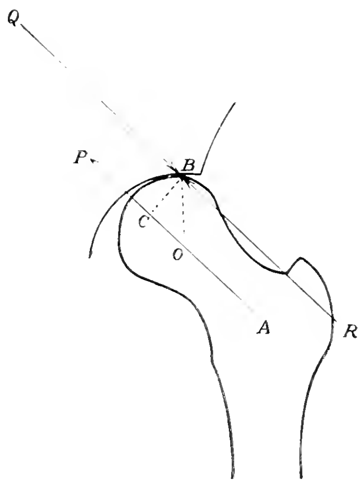


FIG. XXIV.
Normal femoral neck and flattened socket. The couple AP×BC is, as in coxa valga and in coxa vara ∴ cos LCBO, hence also ∴ cos of angle at which AP is to horizontal.

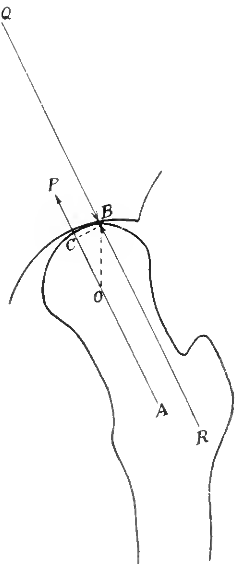


FIG. XXV.
Coxa valga and flattened socket. In coxa valga the couple of the acting forces is smaller than normally. The horizontal component of BR, *i. e.*, the one that evokes shearing stresses, is also smaller than normally. Primary coxa valga offers a certain protection from coxa plana.

Note that in the above figures the hip-socket is flattened. Now in the normal neck of Fig. XXVII. the convex-sided bone elements b appear to be practically excluded from transmitting pressure stresses to the

pelvis, since their ends are not in contact with the socket. And the fact that the pressure has to be borne almost exclusively by the concave-sided elements, is the chief cause of their plasticity through excessive weight-bearing. This also holds good for coxa vara (Cf. Fig. XXIX.). In this the convex-sided elements are made to bear tension stresses, which, as has

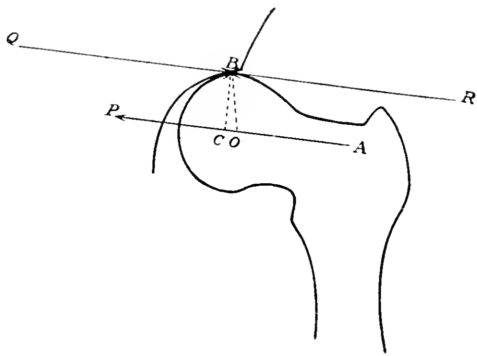


FIG. XXVI
Coxa vara and flattened socket.

In coxa vara both couple and shearing stresses exceed the normal. Primary coxa vara, therefore, enhances the chance of deformation of femoral head and neck in case of flattened socket.

been said in the above, lack the power of stimulating bone-formation. These elements, therefore, are bound to atrophy and possibly to be lengthened or fractured. In coxa valga, on the contrary (Cf. Fig. XXVIII.) the convex-sided elements (*b*) assist the concave-sided elements (*a*) in transmitting the vertical stresses to the femoral shaft and reversely.

Hence it is not doubtful that the deforming effect of the stresses evoked in the femoral head by flattened socket is less than normal in coxa valga; greater in coxa vara.

In flattened socket (a primary) coxa valga offers a certain protection from rotation and displacement of the femoral head, from flattening and widening of head and neck, in short, from the development of coxa plana.

Flattened socket on the contrary threatens (a primary) coxa vara with increased deformation, viz., bending, eventually fracture of the femoral neck.

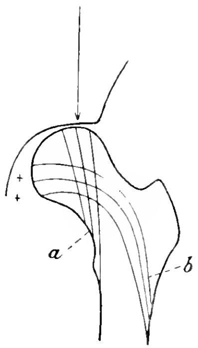


FIG. XXVII

Normal femoral neck and flattened hip socket. The convex-sided bone elements (b) transmit no pressure excesses to the hip socket.

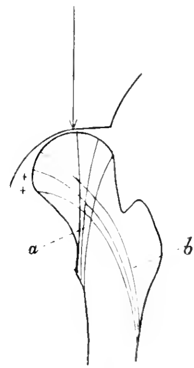


FIG. XXVIII

Coxa valga and flattened hip socket. The convex-sided bone-elements (b) assist the concave-sided (A) sooner than normally in bearing the pressure stresses. Coxa valga therefore offers some protection from deformation of head and neck also with regard to the vertical stresses.

Within the limits of the normal the angle between the femoral neck and the shaft is said to vary 5-10°. Moreover, the amniotic sac which, when remaining too small, levers the femoral head out of its socket, also brings about changes in the position of the femoral neck. Inasmuch as the levering forces are at right angles to the plane of the axis of femoral neck and shaft, they are able only to produce the well known anteversion of the neck. Inasmuch, however, as they act at oblique angles to this plane, they are able, moreover, to modify the angle made by neck and shaft. It, therefore, may be assumed that in the same individual the angle between femoral neck and diaphysis may differ on both sides, especially in congenital dislocation and in flattened socket.

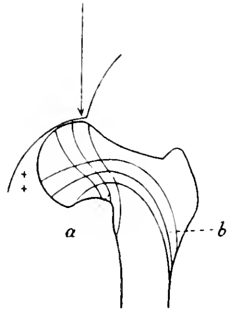


Fig. XXIX
Coxa vara and flattened hip socket.
The convex-sided bone-elements (b) do not assist the concave-sided (A) in bearing the pressure stresses. They are submitted to greater tension stresses than normally. These are no trophic stimulus for bone formation. Coxa valga enhances the chance of deformation of femoral head and neck also by the vertical stresses

These few degrees of difference may, according to the above, have a share in determining whether flattened socket will cause coxa valga, coxa plana, or coxa vara.

(e) *Effect of the degree of enfeeblement of the individual.*

In the beginning of this paper we have tried to show that the development of coxa plana implies the existence of a place of lessened resistance in the femoral neck near the growth-disc. If that area should be mechanically equivalent to the surrounding parts—as may be deemed probable in unenfeebled individuals—flattened socket would tend to

place the normal femoral head in a valgus position. The less enfeebled the individual, therefore, the more flattened socket will tend to develop coxa valga. The more enfeebled the individual, the less is the resistance near the growth-disc in the femoral neck, i.e., the greater the tendency to develop coxa plana.

It is well known that in the normal hip-socket, enfeeblement of the individual enhances the chance of a bending of the femoral neck, i.e., of the development of the coxa vara. Hence the enfeeblement of an individual (through injurious agents, whatever their nature), during growth enhances in two ways the chance of progressive deformation of femoral head and neck in case of flattened socket, i.e., strongly tends to produce coxa plana, coxa vara, and even fracture of the femoral neck.

But there is more: It is well known that in the normal hip-socket enfeeblement of the individual enhances the chance of a bending of the femoral neck, i.e., of the development of coxa vara. Hence the enfeeblement of an individual (through injurious agents, whatever their nature), during growth enhances in two ways the chance of progressive deformation of femoral head and neck in case of flattened socket, i.e., strongly tends to produce coxa plana, coxa vara, and even fracture of the femoral neck.

(c) *Effect of the degree of flattening of the hip-socket.*

For completeness' sake it should be observed that in cases of slight flattening of the hip-socket the gap (on the mesial side) between head and socket may soon be filled up, and thus the action of the couple of forces as well as the shearing stresses be overcome. The socket then fits round the head, and all elements in femoral head and neck get their share in bearing the stresses of function; and every reason for the socket to deform femoral head bone and neck is lacking. Slight flattening of the hip-socket, therefore, *ceteris paribus*, leads to slight flattening of femoral head and neck.

It is obvious that internal factors, apart from external ones (traumata), may determine that in one patient two of the three conditions in question occur as may be illustrated by the following figures. And if we call coxa valga, coxa plana, and coxa vara juvenilis (fracture of the neck) 0, 1, and 2 successively after the degree of enfeeblement which furnishes the best chances for their respective development, it may be anticipated that 0 and 1, or 1 and 2 will meet more frequently than 0 and 2. But, be this as it may, *certain it is that the frequent coincidence of coxa valga, plana, and vara in various cases of flattened socket, pleads in favor of their mutual relationship.*

The coincidence of coxa plana on one side and fracture of the femoral neck on the other in flattened socket is shown by Fig. XXX, B., girl, 8 years, with serious enfeeblement of the power of growth ("rickets"). Her father has congenital dislocation of hip. On both sides the socket-floor is too thick; the right side, moreover, presents ischium varum. So on both sides the socket-line is partly straightened out, which is enhanced by the sloping direction of the socket-roof. On the left side a characteristic coxa plana has developed in latero-position. On the right side, where the coincidence of ischium varum and a too thick socket-floor causes the ischio-pubic part of the socket to depart still more from the head than on the left side, the downward stresses from the iliac part of the socket have simply displaced downward the head and part of the neck, and broken the femoral neck without any trauma having occurred. This case is not unique. We have observed flattened socket coinciding with severe coxa vara in other patients. That in this case fracture of the neck, or severe coxa vara, has developed on the right side and coxa plana on the left may be due:

1 to the fact that on the right side the socket is more flattened,

2 to the fact that the primary position of the femoral neck approached the varus position more on the right side than on the left; and

3 to external causes, although no abnormal strain can be traced.

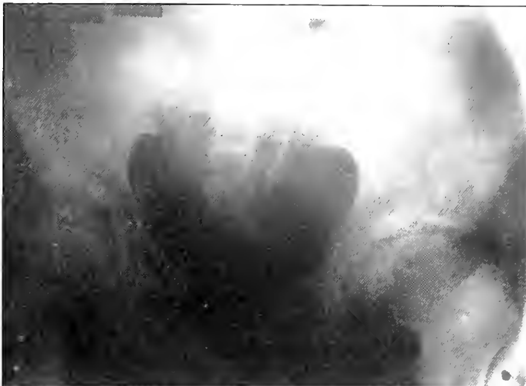


Fig. XXXI

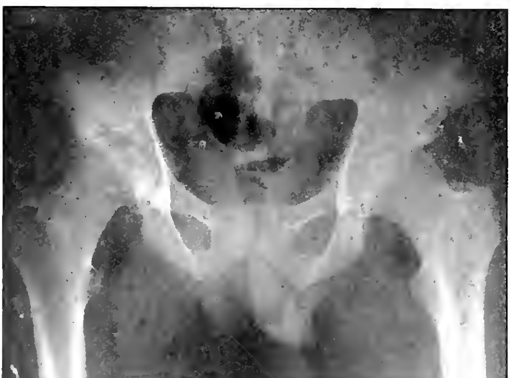
Needless to say, the enfeeblement of the power of growth can never account for any difference on the two sides, since feebleness of growth is symmetrical.

The coincidence of coxa valga and coxa plana completa in the same subject is shown in Fig. XXXI., girl, 15 years. The left side presents coxa valga in latero-position with a too thick socket-floor. The socket-line is far more straightened on the left side than on the right, so there the couple of forces and the shearing stresses have been stronger than on the right side, which may account for the development of coxa plana on that side. The head of the coxa valga is flattened, so the mesial border of the neck is higher than the upper border of the foramen obturatum. The neck is a little wider near the growth-disc than in the middle. It is doubtful whether it is widened out. There is no displacement of the head.

Fig. XXXII., S., boy, 14 years, with congenital rigidity, shows ischium varum on the right side, a too thick socket-floor on the left. There is coxa valga on both sides, on the left dislocated a short time before the x-ray was taken. On both sides there is flattening of the head; neck and growth-disc are widened out a little.

Fig. XXXIII., Th., man, 21 years, presents coxa valga with ischium varum on the right side. The slight flattening of the head causes the

R Fig XXXII L



R Fig XXXIII L

mesial border of the neck to stand too high, but there is no shortening of the neck. The left arm of this man is dwarfed and moreover shows dwarf fingers. Elsewhere we have brought forward reasons for the assumption that too small an amniotic sac may compress flexible parts of the embryo, squeeze the blood out of them, and thus cause local dwarfing, while other parts of the embryo continue their development undisturbed. We, therefore, imagine that the dwarfed arm and the ischium varum have a common cause in too small an amnion. There is pain and crepitus in the joint; but perfect health and no reflex-stiffness. The socket-roof presents irregular decalcified spots at the site of contact with the head (the response of the socket to the concentrated pressure of function: decalcification and plasticity of bone) just above the articular cartilage. In the socket-roof of coxa plana and coxa vara the same phenomenon may present itself. The light spots are observed more laterally, nearer the socket-border, in cases where the neck approaches the varus position.

The previous pages lead to the assumption that flattened hip-socket—either through a too thick socket-floor or through ischium varum—may caeteris paribus cause coxa valga in unenfeebled subjects, coxa plana in the slightly enfeebled, coxa vara and fracture of the neck in those who have been seriously enfeebled by injurious agents, and that where two of these conditions meet in the same individual, a primary difference in the position of the femoral neck or in the form of the socket, as well as external causes (traumata), may be responsible.

The following may give a short account of the consequences of flattened hip-socket, as described in the above study.

A, in subjects with slight enfeeblement (of the power of growth),
B, in unenfeebled subjects,
C, in subjects with severe enfeeblement (of the power of growth).

In doing so we will consider a hip-socket with serious flattening in which early co-aptation of the joint-surfaces is impossible, and thus the deformation of the head may be complete.

> Enfeeblement of the power of growth is brought about by injurious agents which act on a child, either before or after birth, or on the germ cells from which it develops. In cases of slight enfeeblement only the parts growing most rapidly sustain enfeeblement of their power of growth, in more severe cases in succession also the parts which grow less rapidly.

In *slight feebleness of growth* it is only the power of growth of the muscles, which constitute 43% of the body-weight in the normal adult, and thus normally claim about as much of the power of growth which is enfeebled: there are flat feet, prominent abdomen, round back and acrocyanosis.

In *moderate feebleness of growth* signs of enfeeblement become, moreover, manifest in the skeleton, which constitutes 17% of the normal body-weight. This again is first observed in the skeletal parts which grow most rapidly, viz., in the growth-discs near the knee. They show decrease of growth to increase of pressure—the outcome of enhanced fatigability, which in its turn is associated with enhanced irritability.

In *severe feebleness of growth, moreover*, all other growth-discs show enhanced fatigability. There is retardation of growth and extra-retardation of differentiation.

For further information cf. "Feebleness of Growth and Congenital Dwarfism."

A. *The consequences of flattened hip-socket in subjects with slight feebleness of growth.*

Imagine a child in whom the flattened hip-socket is associated with feebleness of the musculature and slight genua valga or none at all. The couple of forces and the vertical component of acting forces (Cf. Figs. VIII. and IX.) cause increase of pressure to the lateral parts of the growth-disc in the femoral neck, decrease in the mesial part. This leads to a difference of growth between the medial and the lateral parts of the growth-disc, agreeing with what occurs in the growth-discs near the knee during the development of knock-knee. In the femoral neck this difference of growth becomes manifest in the rotation of the growth-disc to the horizontal. This rotation is slow and may take up years, as well as, for instance, the development of knock-knees.

As the growth-disc approaches the horizontal, the action of the shearing stresses may become patent; the chance of lateral displacement and hence of vascular lesions which also have been brought about during the development of the angular irregularities becomes greater. Traumatized areas in the bone in the vicinity of the growth-disc start reparative processes comparable to those in bone fractures associated with resorption of limesalts and callus-formation. (Decalcified spots in femoral head and neck). Enhanced plasticity ensues. If weight-bearing is

obviated, a chance of renewed firmness of the bone is opened. The continuation of weight-bearing, however, during the reparative process is comparable to early weight-bearing in case of fracture: it maintains plasticity. This starts in the vicinity of the growth-disc and spreads from there, which becomes manifest in the pear-shape of the femoral neck. The vascular lesions near the growth disc thus are probably the *conditio sine qua non* for the very considerable flattening of head and neck. If the shearing stresses last, a vicious circle is set going. The supposition seems justified that reflex stiffness develops, when the vascular lesions and their consequences surpass certain limits (*coxa plana contracta*).

As the femoral head and neck widen out, the area of contact with the socket enlarges. The action of the couple of forces then diminishes and the rotation of the growth-disc comes to a standstill. The plasticity, however, once brought about, remains on account of the continuation of weight-bearing; progressive thinning and widening of the head and shortening and broadening of the neck presents itself. From the pear-shape of head and neck it may be concluded that in the head and upper part of the neck the plasticity is greatest. The fragmentation of the head is the manifestation of an insufficiency of plasticity with regard to the demands.

Re-union of the parts and, in the adult, the disappearance of the growth-disc follow. The presence of considerable flattening, shortening, and widening of head and neck in advanced years bear testimony to the early development of these changes. (Cf. B).

If even in advanced years the area of contact between head and socket is smaller than normally, the deformation may continue and is more and more identical with the way to be described under B.

B. Consequences of flattened hip-socket in unenfeebled subjects.

In the rotation of the growth-disc the area of the femoral neck in its vicinity mechanically behaves as an area of lessened resistance such as cannot be assumed to exist in normal bone substance. In proportion as the subject is less enfeebled, is nearer the normal condition, the couple of forces tends more to raise the whole of the femoral neck into a valgus position. During this rotation of the femoral neck the couple of forces becomes smaller and smaller as well as the action of the shearing forces (Cf. Figs. XXIV and XXV) and with it the chance of vascular lesions and plasticity through reparative processes. The causes of flattening, shortening, and widening of the neck thus exhaust themselves in the erection of the femoral neck.

During the erection of the femoral neck the bone elements on the convex side participate more and more in bearing the vertical stresses which throng into the head through the small area of contact with the socket. Thus the danger of excessive weight-bearing, shortening and widening becomes less.

While in flattened socket coxa valga on the one hand the chances of flattening and widening of head and neck are lessened, on the other hand the incongruence between head and socket is enhanced. Thus in coxa valga the chance of the joint cartilage being worn at the area of contact is larger than normally. Decalcified spots just below the articular cartilages present themselves. They correspond to the highest point of the femoral head and therefore present themselves in coxa valga more mesially than in coxa vara.

In proportion as the bone is firmer, —i.e., as the subject is nearer the normal condition—or also in proportion as these phenemena develop later in life—as in cases of slight incongruence—the deformation of the head is limited to more superficial layers. Hence in more advanced years lipping is observed; plasticity of the upper layers of the femoral head only, "mushroom" formation. The supposition seems justified that, as an attempt at restoration, blood vessels widen out and bring about this lipping, which is characteristic of all excessive weight-bearing in articular surfaces. The condition is known under the name of "osteo-arthritis," "arthritis deformans," or "malum coxae." We call it "*joint-wear*," *in casu* "*hip-joint wear.*"

C. Consequences of flattened hip-socket in subjects with severe enfeeblement of the power of growth.

Imagine a child in whom all growth discs show differences of growth by their oblique position with regard to the diaphyses, and a curving of the latter. Suppose there is slight symmetrical coxa vara and flattened hip-socket only on one side.

The growth disc is, by the couple of forces, relatively easily made to approach the horizontal. From a mechanical point of view the vicinity here offers less resistance than in slightly enfeebled and unenfeebled subjects. This implies that, in proportion as the enfeeblement of the power of growth is more intensive, the femoral neck itself is less affected by the erecting power of the couple of forces evoked by the flattened hip-socket.

The convex sided elements in the femoral neck are more curved than normally. Therefore the moment of the vertical component of the act-

ing forces which tends to bend these elements, is *ceteris paribus* greater than normal. These convex-sided elements, moreover, lack more of the trophic stimulus of function in proportion as the varus position is more developed; their mesial end is less in contact with the socket floor and can therefore transmit less pressure to it. In other words, in coxa vara there is more reason for their atrophy than normally.

Flattened hip-socket in severe feebleness of growth thus enhances the chances of further bending, and even of fracture of the femoral neck.

It thus appears that seemingly dissimilar and even contrasting conditions—coxa plana, valga, vara, (fracture of the femoral neck) malum coxae—may have a common cause in flattened hip-socket, i.e., ischium varum or thick socket-floor.

It stands to reason that differences in the primary position of the femoral neck, differences in the form of flattened socket—as for instance wry socket or sloping socket roof—transitions between the degrees of feebleness of growth described, differences in the amount of rest and weight-bearing, and possibly a complication with infection, may in each special case of flattened hip-socket render it difficult to recognize the developmental forms just sketched.

In conclusion, we will compare the hypotheses hitherto brought forward concerning the cause of coxa plana with the theory of the previous pages. They are mainly: "rachitis," traumata, infection, congenital abnormalities of the femoral head. The first three are based on facts observed in conjunction with coxa plana. The last one is not. Nor does it explain any of the phenomena, but obscures them by the addition of more obscurity.

"*Rachitis*" (severe feebleness of growth), be it in its less severe form, has in the above proved to be a promotive agent of the development of coxa plana.

Of *traumata*, vascular lesions have indeed seemed apt to occur as a result of the rotation and displacement of the head. Of external forces, it must be admitted that they may promote fragmentation as well as flattening and widening of femoral head and neck.

Infections in other parts of the body may act as an injurious agent and cause enfeeblement which leads to the development of coxa plana, while on the other hand bacteria doubtless find a prepared soil in the femoral head and neck themselves, especially during the fragmentation stage, inasmuch as circulation and nutrition have been injured in broken up parts.

Calot and the author have, moreover, expressed the opinion that coxa plana should be due to a congenital subluxation of the hip (a too thick socket-floor). The addition of the ischium varum (i.e., the widened socket) in the present paper may be considered a completion of this notion.

The theory of the previous pages thus encompasses the professed hypotheses. It takes into account the facts on which they are based and points out the position they occupy in the development of this hitherto obscure condition. But, moreover, it makes us understand why so very few people who show signs of feebleness of growth are affected by coxa plana, and, if so, often on one side only, in this so exceptionally symmetrical condition; why serious traumata may act with impunity on the great majority of children, while in those under discussion a slight trauma may call forth or increase the phenomena; and finally why most of these conditions develop without the slightest signs of infection, while only a small percentage with reflex-stiffness around the hip raises suspicion of a bacterial focus or develops a culture upon bacteriological examination.

And the answer to these various "why's" seems to have been brought chiefly by 1° the two phenomena, *ischium varum* and the *too thick socket-floor*, which produce the widened and flattened acetabulum; and 2° by rules of bone growth,—formation and deformation in relation to mechanical stresses.

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MEASUREMENT OF THE RANGE OF MOTION IN JOINTS.*

BY DAVID SILVER, M.D., PITTSBURGH, PA.

Measurement of the range of motion in a joint is of value as a means of control in treatment and of record in military and medico-legal work. Considerable uncertainty seems to exist as to the proper point from which the degree of motion is to be estimated, and there does not appear to be any agreement as to the best and most accurate method of measurement. The following method is therefore suggested, as simple, easy of execution, and sufficiently accurate.

Protractor. A protractor of the simplest kind, with a long arm, is necessary. At the proper place in the centre of this arm is a heart-shaped opening through which the scale is read. A stand is provided with a hinged upright, to which the protractor is attached, in such a manner that it can be moved upward and downward in the vertical plane or folded so as to lie in the horizontal plane. This adjustment is arranged so that the protractor may be used in either the vertical or the horizontal positions and so that the center of its arc corresponds with the center of the joint measured.

Requirements as to Position. For accurate measurement, one segment of the joint which is to be measured and the base of the protractor should be firmly fixed in the same plane. This is ordinarily most easily accomplished by resting the entire upper segment of the joint on a table, the patient being in the recumbent position; the protractor is then placed beside it and the center of its arc raised until it coincides with the center of the joint.

The mensuration of the degrees of motion in joints must start from a zero plane. The zero plane in measuring joint motion shall be considered to be an extension of the plane of the long bone or bones immediately proximal to the joint in question.

In the hip and the shoulder, the lateral and the antero-posterior planes of the trunk shall be considered the planes of zero. In the spine, the degrees of motion shall be measured from the zero of the centre of gravity of the body.

*This method of the mensuration of joints was devised during the war, but, though approved for publication by the Surgeon-General on May 16, 1919, was never published. It is presented now in the hope that it may aid in the establishment of a standard.

Acknowledgment is made of the valuable assistance given by Dr. R. B. Maddox in the designing of the protractor, and also of the helpful criticism of Drs. Kendall Emerson, Robert B. Osgood, and R. Tunstall Taylor.

SHOULDER JOINT.

Abduction. Position: patient lying on back with body straight and arms at side; protractor folded on its stand and laid on the shoulder so that its base coincides with side line of body and the center of its arc with center of joint; indicator points toward hand and registers zero. A finger should be kept on the scapula to note when it begins to move. In this position abduction is normally 90 degrees without movement of the scapula.

Forward Elevation. Position as above; inner surface of protractor is placed against outer surface of shoulder and the center of its arc raised to coincide with center of shoulder; indicator points toward hand and registers zero. In this position forward elevation is normally about 110 degrees.

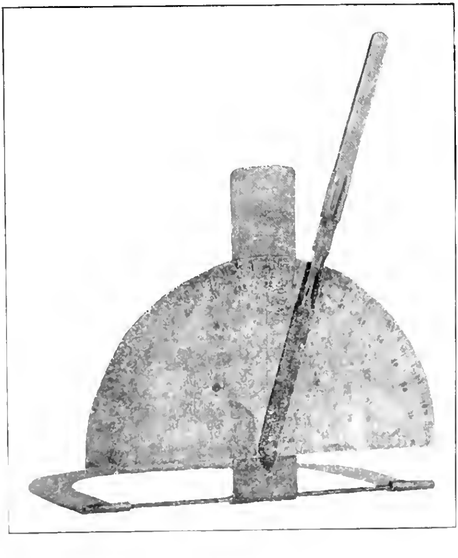

FIG. 1.

The original protractor, reduced to about one-third actual size, seen from the front. The protractor itself is shown partly raised on the hinged upright of the stand. The indicator, which is provided with a sliding extension, is shown closed.

Rotation. Position: Patient lying on back; arm abducted at right angles from body at shoulder; forearm flexed to right angle at elbow and held perpendicular; inner surface of protractor is placed against outer surface of elbow. Scale is read from 90 degrees, considered as zero. In this position outward and inward rotation are practically about 90 degrees.

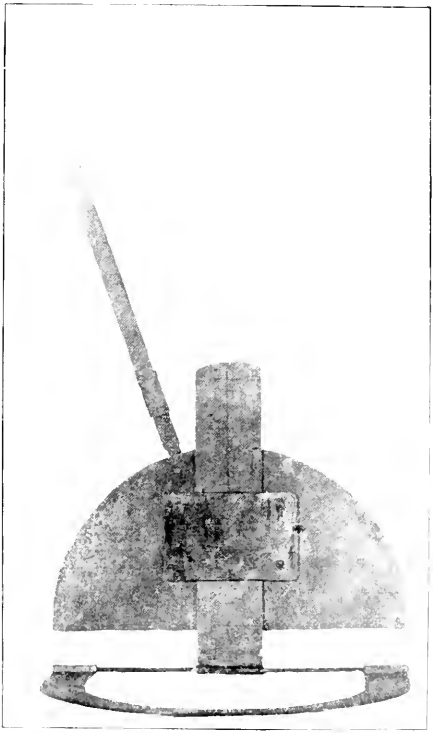

Fig. 2.
The original protractor, seen from the back. The indicator is shown opened.

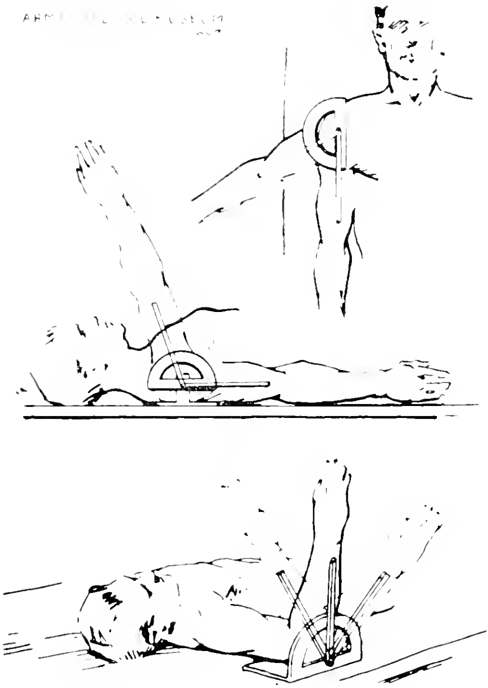

Fig. 3
Upper: Position in measuring abduction of the shoulder.
Middle: Position in measuring forward elevation of the shoulder.
Lower: Position in measuring rotation of the shoulder.

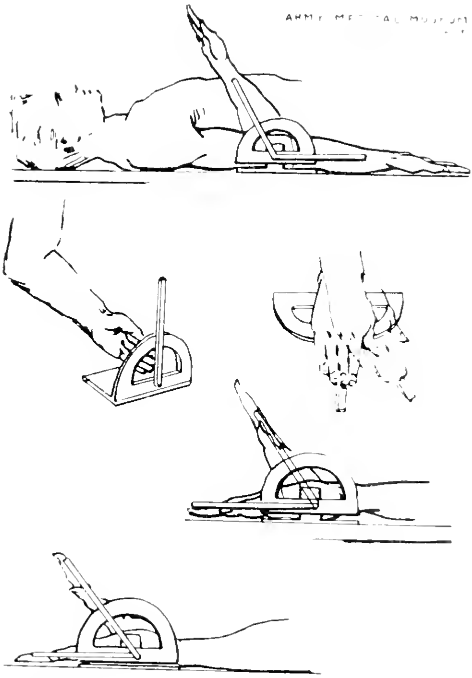

FIG. 4

Upper: Position in measuring flexion and extension of the elbow

Middle (Left): Position in measuring rotation in the radio-ulnar articulation (pro- and supination).

Middle (Right): Position in measuring ab- and adduction at the wrist.

Lower: Position in measuring flexion and extension at the wrist.

ELBOW JOINT.

Flexion and Extension. Position: patient lying on back with arm extended at side and palm upward; inner surface of protractor is placed against outer condyle of humerus and the center of its arc raised to coincide with center of elbow joint; indicator points toward hand. Full extension is indicated by 0 degrees and full flexion is normally about 140 degrees.

Rotation in Radio-ulnar Articulation (Pro- and Supination). Position: patient lying on back with hand resting on ulnar border and thumb pointing upward, or sitting with elbow flexed to a right angle and resting on a low table; inner surface of protractor is placed against ends of fingers at right angles to long axis of arm, so that the center of its arc coincides with end of little finger. The scale is read from 90 degrees, considered as zero. Measured in this way, pronation and supination are each normally nearly 80 degrees.

HAND.

Flexion and Extension. Position: patient sitting, with forearm resting on a low table, or lying on back with arms extended at sides. Palm is turned upward in testing flexion, and downward in testing extension; inner surface of protractor is placed against outside of wrist and the center of its arc raised to coincide with center of joint; indicator points towards fingers. Flexion and extension are each normally about 70 degrees.

Abduction and Adduction. Position: patient lying on back with arms at sides and hands fully pronated. Fold protractor and place it under arm so that its base is opposite wrist joint and at right angles to long axis of arm, and so that the 90 degree point is opposite the middle finger. In this position, abduction and adduction are each normally about 35 degrees.

FINGERS.

Flexion and extension may be measured with this same instrument, the back of the proximal joint resting on the table; but it will be found more convenient to use instead, the special finger protractor devised at Hart House, Toronto (see McKenzie: Reclaiming the Maimed, p. 68).

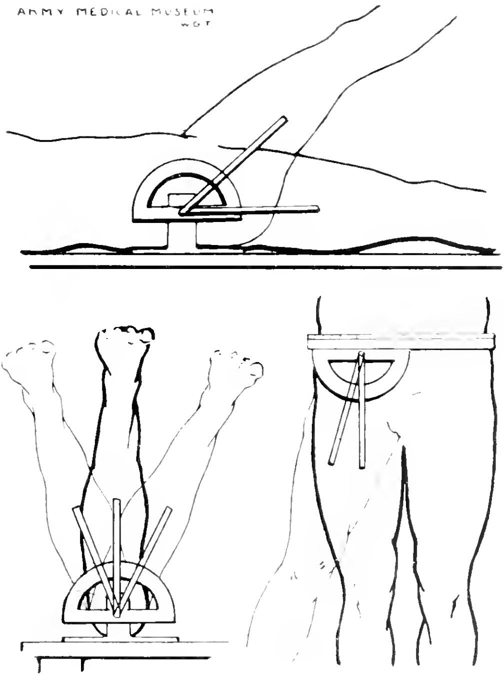

FIG. 5.
Upper: Position in measuring flexion of the hip.
Lower (Left): Position in measuring rotation of the hip.
Lower (Right): Position in measuring ab- and adduction of the hip.

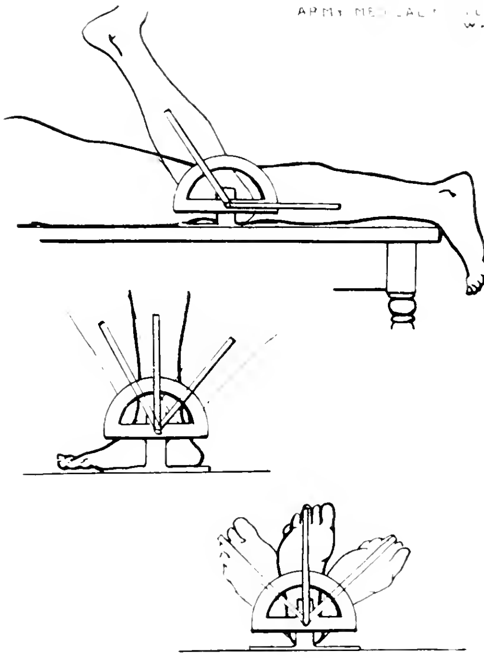

Fig. 6
Upper: Position in measuring flexion and extension of the knee.
Middle: Position in measuring flexion and extension at the ankle.
Lower: Position in measuring ab- and adduction of the foot

HIP.

Flexion and Extension. Position: patient lying on back, with toes pointing directly upward; inner surface of protractor resting against outer surface of hip, with center of arc opposite center of trochanter and indicator pointing toward center of outer condyle; assistant flexes opposite hip to disclose concealed flexion. Normal range of motion is from 0 degrees in full extension to about 130 degrees in full flexion.

Abduction and Adduction. Position: patient as before; protractor is folded; a ruler is so placed that its edge is pressed closely against the lower surfaces of the two anterior spinous processes and the protractor is laid on the hip so that its base rests against the ruler and the center of its arc lies over center of hip-joint. With the leg in the middle position (the toes pointing directly upward) the indicator will point to 90 degrees. Abduction and adduction are each normally about 45 degrees.

Rotation. Position: patient lying on face with knee flexed to a right angle; place protractor so that it rests against the anterior surface of the lower leg at right angles to the long axis of the thigh. The scale is read each way from 90 degrees, considered as zero. Outward and inward rotation are each normally about 45 degrees.

Hyperextension. This may be estimated in a similar manner to flexion and extension but with the patient lying on the face. It is normally about 10-15 degrees.

KNEE.

Flexion and Extension. Position: patient lying on face, with inner surface of protractor resting against outer surface of knee and center of its arc raised to coincide with center of knee joint. Full extension is indicated by 0 degrees and full flexion is normally about 130 degrees.

FOOT.

Flexion and Extension. Position: patient standing; inner surface of protractor rests against outer surface of ankle, center of arc being raised to coincide with center of ankle. Patient bends backward for planter flexion and forward, keeping the knee straight, for dorsal flexion. The scale is read from the middle position (90 degrees). Plantar flexion is normally about 60 degrees, and dorsal flexion about 20 degrees.

These measurements may be taken in a similar manner with the patient lying, by placing a board against the foot on which the protractor is then rested.

Abduction and Adduction. Position: patient lying; inner surface of protractor placed against sole of foot with the 90 degree point, considered as zero, opposite the middle toe. The leg must be held firmly to prevent it from rotating. Abduction is normally 10 and adduction 30 degrees.

THE RELATION OF LESIONS OF THE TRANSVERSE PROCESSES TO PAIN IN THE BACK AND LEGS

BY GEORGE I. BAUMAN, M.D., CLEVELAND, OHIO

In cases of lumbo-sacral pain and in cases with pain referred down the leg, whether with or without definite history of injury, the possibility of anomalies of or injury to transvere processes should be given careful consideration in differential diagnosis. Routine x-ray examinations and dissections of the lumbar spine reveal wide variation in the length, shape, and direction of the transverse processes. These variations are not limited to any one segment of the spine, although the fifth lumbar process is the most frequent site of congenital abnormality.

The nerve cords of portions of the lumbo-sacral plexus and some of their branches lie in close proximity and directly anterior to the transverse processes of the last four lumbar vertebrae. Any slight change in position of one or more of these processes, due either to fracture or to slight rotation of the vertebral body can result in direct pressure by the process upon the underlying portions of the plexus. The irritation of these nerve cords or branches may be responsible for numerous neurological symptoms in their field of distribution. It may be evidenced by pain, numbness, atrophy, paresis or paralysis, in certain areas of distribution of these nerves. The etiology of a number of obscure cases of lumbo-sacral neuritis, the majority resembling sciatica, has been explained upon this intimate anatomical relationship.

Attention has been called by Richard (1) to the incidence of lumbo-sacral pain and referred pain, associated with congenital malformation of the transverse process of the fifth lumbar. He concludes that the referred pain is due to (a) compression of soft tissues, (b) irritation and arthritis of abnormal joints and bursae, (c) slow acting strain on the ligaments or (d) to pressure or tension of the segments of trunks of nerves. Lavieri (2) refers to elongation of the fifth process as a cause of backache. Moore (3) has recently published a series of cases in which such a group of symptoms was relieved by removal of a portion of the offending fifth process. Davis (4) in 1919 reported a series of ten cases of fracture of the lumbar transverse processes, which were removed with excellent results. He concludes that such fractures are not unusual as a result of indirect violence.

During the past eighteen months there have come under my observation on the orthopaedic services of Lakeside Hospital and Cleveland City Hospital twenty cases which have presented a combination of history, physical findings, and frequently x-ray evidence, indicating some lesion of one or more of the lumbar transverse processes. The duration of symptoms has varied from three weeks to six years. Fifteen of these gave a definite history of sudden injury, in most cases indirect in type. Two additional cases gave a history of possible injury. Two of these complained of pain in the back only. Thirteen complained of pain in both back and groin, buttock, thigh, or leg. Five had referred pain only. Two complained also of numbness, paraesthesias or weakness. The most constant pain on motion was in flexion. Atrophy of muscles of the buttock, thigh, or calf was noted in four instances.

The most constant finding in these cases, and the one to which I have been led to give much significance, is the location of a definite highest point of tenderness to deep pressure over the tip of one of the transverse processes. In a number of instances the patient volunteered the information that he experienced "pain down the leg" in addition to local tenderness, when pressure was made directly over the site of the lesion. Attention should be given to the fact that the tip of an abnormally long offending transverse process may be located at a considerable distance—two to four inches—lateral to the mid line. In some thin individuals abnormally long processes of the first, second, and third lumbar may be palpable. X-ray examination of this group of cases revealed congenital abnormalities, in size or shape, in six instances. Some, however, appeared perfectly normal. One showed partial necrosis. One showed definite fracture of two processes. Operation revealed a third fracture which did not show in an excellent stereoscopic x-ray view.

The history and the physical and x-ray findings have been considered sufficient justification for operative interference in nineteen instances. Resection of one or more transverse processes was performed. In one recent case operation has been advised. Brief summaries of the histories of these patients are given below.

Case 1. S.F. A white laborer, age 41 yrs., complained of pain in back and left hip of two years duration, following an injury. He had been able to do some light work, but was not able to work at his occupation as a carpenter. Pain had been continuous. At times he had been confined to bed, and on admission local signs were so marked that he was sent in as a suspected case of tuberculous spine. Examination showed localized tenderness over the fifth lumbar transverse process on the left.

X-ray showed a greatly elongated fifth process on each side. Transversetomy was performed on the left. Symptoms had disappeared at the time of discharge, and at the end of about six weeks he was able to resume work at his former occupation as a carpenter. Two years later this patient received a severe twist of the back in a street car accident and returned with identical symptoms of the right side. Removal of the abnormal right process has been advised.

Case 2. M.M. A white female, 37 years of age, complained of pain in the back and down the inner and anterior aspect of the right thigh, for a period of two years and nine months. The onset was sudden, when the patient reaching across a bed to lift a heavy mattress, felt a sudden sharp pain in the lower back. Since that time she has been troubled constantly with pain in the back and pain radiating down right leg. Manipulation and plaster corset had given no relief. She entered the hospital on crutches. Examination showed marked tenderness, muscle spasm, and rigidity of the lumbar spine, with a maximum point of tenderness a short distance to the right of the spine of the fourth lumbar vertebra . X-ray showed a slight upward angulation of the transverse process of the fourth lumbar, with indication of an old fracture at its base. Resection of the right transverse process was performed. After removal of the process several small fragments of bone were found adherent to the nerve cord lying directly beneath. These were carefully dissected away. No indication of a line of fracture was, however, found. The patient can now walk considerable distances without any means of support, using a cane only at times. She has much less referred pain than before operation.

Case 3. J.M. White male, age 40 years, complained of pain in the back and radiating to the right hip, six months duration. No history of trauma. He has no pain while at rest in bed, but pain on turning over and when up. Physical examination showed limitation of flexion and hyperextension and muscle spasm on the right. X-ray showed abnormally long transverse processes on the right of the fourth and fifth lumbar. Plaster corset for four weeks gave temporary relief but the pain soon returned, greater in intensity. The fifth right process was removed. At the end of six weeks the patient returned to work. He has had no recurrence of pain in back or hip.

Case 4. C.K. A white male, laborer, gave a history of a sudden severe pain in the left lumbar region and extending down the left leg. This followed a sudden twist when the patient stepped, without warning, into a hole, while he was carrying a heavy packing case. He was unable

to do any kind of work. Examination revealed marked tenderness to pressure over the left fifth lumbar process with accentuation of pain down the leg. X-ray showed a large, irregular left process of the fifth. Operation: resection. Pain has entirely disappeared, and the patient returned to his former work at the end of six weeks.

Case 5. W.L. Patient a white laborer, age 34 years, gave a history of sudden onset of pain in the lower lumbar region and referred down the back of the thigh and outer side of the leg. This began with a sudden sharp pain when he attempted to hold the entire weight of a heavy casting, after the fellow workman helping him had stumbled. X-ray showed very large sacralized transverse processes of the fifth lumbar, with the largest on the left. Manipulation under anaesthesia, followed by plaster spica and recumbency for four weeks, gave no relief. The patient had definite localized tenderness over the left fifth process, accompanied by accentuation of leg pains. Resection was performed. Immediately on removal of the process the nerve trunks lying beneath bulged upward into the space which the process had occupied. Edges of the base were carefully smoothed off. Following the operation the patient had some anaesthesia of the areas supplied by the superficial peroneal nerve. He had no paralysis or paresis. The anaesthesia disappeared after a few days. The patient's symptoms cleared up entirely and he was able to be back at work at the end of six weeks.

Case 6. C.M. Patient suffered severe pain in the lumbar region after being struck by an automobile and hurled to the pavement. There was no external evidence of trauma, but the patient had exquisite tenderness over the transverse processes of the second, third, and fourth lumbar vertebrae on the right. Excellent stereoscopic x-ray plates showed definite fracture of the third and fourth. Operation revealed also a fracture of the second process, which could not be detected on careful re-examination of the plate. Recovery was complete after removal of the three fractured processes. This case is offered as an illustration of multiple fracture of transverse processes as a result, apparently, of indirect violence. It also illustrates the fallacy of depending entirely on x-ray for the diagnosis of fracture in this location.

Case 7. J.A. White male, about 40 years of age. Occupation: policeman. Illness began one and a half years previous to first admission, with pain in the calf of the right leg, which gradually progressed upward into thigh and hip. He had pain in the thigh for eight months, and severe enough to force him to go to bed sx months previous to admis-

sion. He was in the hospital on several occasions. Manipulation under anaesthesia and application of plaster spica cast for four weeks was of temporary benefit. X-rays were negative, but the patient had definite localized pain to pressure over the fifth right process. Resection of this process was performed and after removal there was found a small, firm, fibrous band beneath, pressing upon the nerve trunk. This band was dissected away. Following operation the pain disappeared gradually, and he is now able to be on duty. He experiences only a slight amount of pain on over-exertion.

Case 8. K.M. A white female, age 32 years, complained of pain in the region of the left hip only. She had been confined to bed for seven weeks previous to admission. There is a questionable history of injury. There was some pain to extreme flexion of the hip, but no point of tenderness in the hip region. Posteriorly in the left lumbar region, about three inches to the left of the spinous process of the third lumbar vertebra, was a palpable, bone-like knot, very tender to pressure and movable antero-posteriorly. The pain in the thigh was greatly accentuated by pressure on this transverse process. The third process on the opposite side was easily palpable but not tender. The pain in the thigh and the point of tenderness in the back persisted after two additional weeks rest in bed in the hospital. Repeated x-ray examinations of the sacro-iliac region and hip were negative but both third processes were abnormally long. There was no evidence of fracture. Operation was considered advisable because of the persistence of tenderness of the palpable process and the accentuation of the hip pains. The process was found to be about two inches long and with its distal three-eighths of an inch, attached by a fibrous, flexible connection. This distal portion was freely movable. On removal of the process a lumbar nerve appeared just beneath the distal fragment. The pain in the hip was entirely relieved and the patient now, eight weeks after operation, is able to be about and do her own housework. Note that the movable distal fragment, either an anomaly or an old fracture, was not detected by x-ray examination.

Case 9. S.H. Patient, a white male, 40 years of age, gave a history of pain in the right hip for eight months following a fall. There was no pain on motion of the hip joint. Some atrophy of the muscles of left thigh, buttock, and calf. Pressure over the sciatic nerve caused no pain. Hyperflexion of the thigh, however, caused considerable pain down the leg. There was marked tenderness to deep pressure in the right ilio-vertebral angle which caused the patient to complain of pain

down the leg. Rectal examination was negative. X-ray of the lumbar spine showed some proliferation at the margins of the vertebral bodies. Persistence of the point of tenderness with the accompanying referred pains was considered justification for exploration of the transverse processes of that region. Excision of the fourth and fifth right processes was performed. Patient left the hospital still complaining of some pain. He has since reported, however, that he has no further pain. Slight weakness on walking long distances.

Case 10. E.G. Patient, a white male, about 25 years, entered the hospital complaining of pain in the lumbar region and down the legs. Pain came on suddenly on attempting to lift a heavy weight. There had been a previous operation one and a half years before in the right lumbar region, for the incision of an abscess. The wound was healed, x-ray showed possibly a little absorption of the transverse process of the third lumbar on the right. There was a definite point of tenderness here. The vertebral bodies and intervertebral discs were normal in appearance. A diagnosis of osteomyelitis did not seem justifiable at the time of admission. The patient was operated upon at his own request only after repeated casts, braces, and manipulation over a period of one year had failed to give relief. At the time of exploration there was necrosis of a portion of the transverse process and pus was found. It was considered a case of osteomyelitis and the remains of the process were removed and the wound drained. Sequestra were later removed. A pathological diagnosis of bone tuberculosis was made on examination of the process. Extension occurred to the bodies of the vertebrae and patient has since died of bone tuberculosis. This case is given as a rare and obscure lesion accounting for backache and pain in the legs and also as an unusual location for the primary lesion of bone tuberculosis.

Case 11. R.C. Patient was a colored male laborer, 46 years of age. Following a fall while carrying a heavy load, nine months previous to admission, patient has had pain in the lower lumbar region and right leg. This has been continuous but did not entirely incapacitate him for work until a short time before admission. Examination showed tenderness to pressure over the right fifth transverse process with accompanying pain referred down the right leg. No paralysis or paresis. Transversectomy, right fourth lumbar performed. Patient left hospital in two weeks, his condition much improved. When last heard from he was relieved of symptoms and back at steady work.

Case 12. A.C. Patient, a white male, 33 years of age, entered the hospital complaining of pain in lower part of back and referred to the

buttock and part of the thigh on the right side. There was marked tenderness to pressure over the fifth lumbar transverse process on the right with pain referred down the right thigh. X-ray reported negative. Transversectomy of the right fourth and fifth lumbar performed. Patient left hospital at the end of two weeks with symptoms relieved. He is now back at work.

Case 13. A.C. A white male laborer, 30 years of age, complained of pain in the left hip and leg of two months duration. The onset was sudden, beginning when the patient "strained" himself while lifting a heavy load. Manipulation and plaster cast gave no relief. Patient returned again with the same complaint. There was a definite point of tenderness over the left third and fourth transverse processes. These were resected. Patient later returned, still complaining of pain in the leg. At this time the left fifth process was removed. Since this he has been much improved.

Case 14. H.P. Patient is a white male, 47 years of age, complaining of pain and loss of sensation in the left thigh following a fall down stairs three weeks prior to admission. He had marked tenderness over his left fifth transverse process, and pain in thigh was increased with pressure over the tender spot in his back. X-ray showed some rotation of the fifth lumbar on the sacrum. The left fifth process was removed. The patient is now at work regularly in the coal mines.

Case 15. J.M. A white male, age 34 years, twisted his back when he fell while carrying a 100-lb. keg of nails. Complained of pain in the back and radiating down the back of the left leg to the knee. There was definite tenderness over the fourth and fifth processes on the left, accompanied by accentuation of leg pain. One quarter inch atrophy in circumference of right leg. X-ray showed marked rotation of spine and abnormally long transverse processes of the fifth lumbar impinging on the ilium. The entire fourth and part of the fifth left processes were removed. On discharge at the end of three weeks patient had relief of the pain that caused admission. He had some loss of power of flexion of the toes of the left foot. Lately this has decreased in amount.

Case 16. H.T. Age 53 years. A white male patient, had worked twelve years at a machine where he pressed a pedal with the left foot. One year previous to admission he suddenly noticed pain radiating down the posterior portion of the left thigh and ending in numbness and tingling in the foot. The pain was accentuated when working at the machine and when rising from a sitting posture. He had been compelled

to give up his work. Examination showed definite localized tenderness to pressure over the third, fourth, and fifth lumbar transverse processes on the left, causing pain to radiate down the posterior portion of the left thigh. There was no atrophy. The pre-operative x-ray was reported negative. At operation the fourth lumbar transverse process was removed on the left. The patient complained of slight pain in the region of the operation, but no radiation of pain down the leg, two weeks post-operative.

Case 17. F.S. A white male, age 48 years, was in an automobile accident seven months previous to admission. He suffered a "twisted back" and since has had pain in the back when lifting. Examination showed tenderness over the third, fourth, and fifth lumbar transverse processes, with pain radiating around the hip to the right inguinal region. At operation the fifth process on the right was found to be movable and detached. The right fourth and fifth were removed. The patient now states that he has no more pain in the hip or groin, and pain in back is much less.

Case 18. J.P. Age 56 years. A white male laborer gave a history of back strain while lifting a heavy casting seven years previous to admission to hospital. For over two years he has had pain in the lower right back and radiating down the right leg while walking or stooping over. There was localized tenderness over the fourth and fifth transverse processes on the right. X-ray showed some arthritis of the second and third lumbar vertebrae. The fifth lumbar process on the right was removed. On the second day post-operative this patient had excruciating pain in the back and radiating down the right leg. This pain disappeared entirely when a collection of serum in the wound was evacuated. Patient was discharged at the end of eighteen days with no tenderness over the spine and complete disappearance of his previous subjective symptoms.

Case 19. J.S. A white male, age 48 years. Six years ago, fell ten feet from a scaffold and was confined to bed for eight weeks. He has been unable to work since, because of severe pain in the lower right back on walking or stooping over. He has had all manner of treatment without improvement. There was definite tenderness over the tip of the third lumbar transverse process on the right. The large tip was easily palpable. No radiation of pain. X-ray showed bilaterally enlarged processes of the third lumbar, otherwise the x-ray appeared negative. At operation the second process was found to be loose in its distal half and was removed in pieces. The long third process was also

removed. The patient was discharged from the hospital eleven days after operation with entire relief from previous symptoms.

Case 20. M.J. A white female patient 26 years of age, has had backache, pain in the groin, and occasionally numbness and loss of power in the hip since an accident several years ago, at which time she fell across an open drawer striking the lumbar region. She has been treated by various physicians and has received various diagnoses. A diagnosis of movable kidney has not been substantiated by examination in this hospital. She has, however, a palpable long, tender, transverse process on the right opposite the third lumbar. There is practically no other tenderness in the back. Motion is very slightly restricted and painful. After manipulation of the painful transverse process this patient complained of extremely severe pain in the groin and actual muscle spasm in the same region was observed. X-ray showed a long transverse process of the third lumbar with possible fracture near the tip. This patient has been advised to enter the hospital for resection of this process.

This group of cases does not include several of obvious recent fractures of transverse processes. These have been treated by removal but are not included in this group because their diagnosis did not depend, particularly, upon the points which I am attempting to emphasize.

The method of approach in the majority of cases has been through a longitudinal four to six inch incision over the offending processes and about two inches lateral to the spinous processes. The vertebral fascia is divided in the same line and the fibres of the erector spinae muscle separated by blunt dissection. The transverse process is bared, inspected, and freed from muscular and ligamentous attachment. The process is removed carefully with mallet and chisel, and the edges at the base rendered smooth. The close proximity of portions of the nerve trunks necessitates considerable care in this procedure. The fascia is closed with catgut and the skin with clips. In a few cases of large processes of the fifth, with impingement on the ilium, a modification of the approach first described by Bonniot (5) has been used. A vertical incision about 10 cm. in length and extending along and a little inside the external border of the sacro-lumbar mass is made. At the iliac crest it is continued inward, following the crest as far as the posterior inferior iliac spine. The muscle mass is separated with its periosteal attachment from the crest of the ilium, and a wedge of the crest is chiseled away and discarded. As much of the crest is removed as is necessary to expose the low lying fifth process. Closure is made by resuturing the muscle mass to the ilium.

Patients are placed on the back with a small pillow in the lumbar curve. Effort is made to prevent active movement for a period of seven or eight days. Only as much passive movement is permitted as is necessary for removal of clips, inspection of dressings, and care of patient. The period of recumbency has varied in individual cases from nine days to three weeks.

In the majority of cases that I have operated upon the symptoms have been present for long periods—months or years. During this interval some have received many different diagnoses and have had various methods of fixation, baking, etc., without relief. Several have been the patients of the chiropractor, osteopath, spondylotherapist, etc.

These cases are presented to emphasize the frequency of transverse process lesions as a cause of definitely localized pain in the back with accompanying lumbo-sacral neuritis.

In a number of these cases (11) transverse processes other than the fifth lumbar have been the site of the lesions. In four of these both the fourth and fifth were removed.

The x-ray has been a valuable assistance in the identification of abnormalities and certain cases of fractures. In several instances, however, the x-ray diagnosis of fracture proved erroneous. In three instances, fractures present, could not be identified on the x-ray.

Careful examination for points of tenderness, definitely localized, over transverse processes, has been of the greatest value in reaching a diagnosis. Location of these has been found of particularly great significance when accompanied by accentuation of referred pain.

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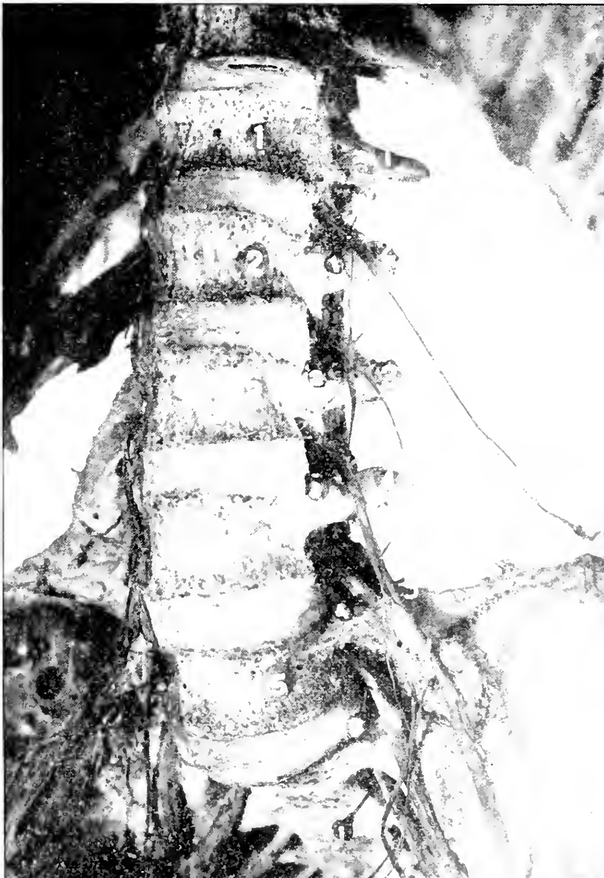

This dissection was made in the Department of Anatomy, School of Medicine, Western Reserve University. It was made particularly to show the intimate relation of the transverse processes and nerve trunks. It is helpful to refer to this in explaining the location of the pain, especially in such cases as 8 and 20.

NON-SPINAL PSOAS ABSCESS

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The frequency with which the orthopaedic surgeon is called upon to diagnose and treat psoas abscesses is due not only to the fact that there is involved an interference of locomotion, but also because it is generally believed that these abscesses are due to disease of the spinal column and the skeletal portion of the pelvis. There exists, however, a group of cases in which the spinal and pelvic bones play no part in the production of the suppuration. It is chiefly with this group of cases that we expect to deal in this paper. Our observations are based on a study of forty-two cases, of which twenty-four have come to our attention during the last four years.

ANATOMY.

The anatomical relationship of the retroperitoneal structures make the psoas sheath the avenue of choice for suppuration originating in these structures. The psoas muscle (Figure 1) has its origin in the sides and transverse processes of the twelfth thoracic and lumbar vertebrae, and courses downward to insert into the lesser trochanter of the femur. Posteriorly, it lies on the spinal column and the quadratus lumborum muscle. In its upper portion, it passes beneath the internal arcuate ligament of the diaphragm. Abdominally, it lies behind the peritoneum in close relation to the kidney, pancreas, and intestines. The vena cava and the genitocrural nerves lie anterior to it, while the lumbar plexus nerves course through it. In the lower portion, it runs over the superior ramus of the pubis, under Poupart's ligament, just under the femoral

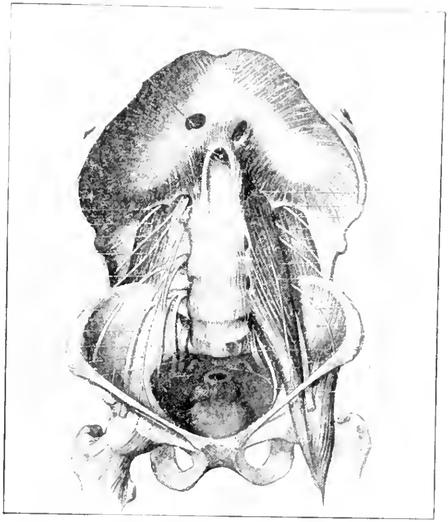


FIG. 1. The posterior abdominal wall, to show the psoas muscle. (After Cunningham.)

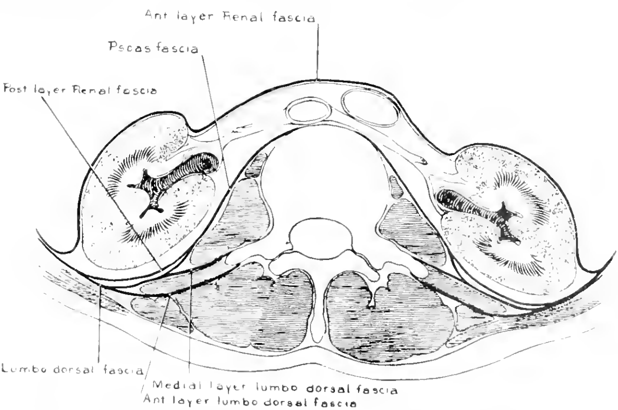


FIG. 2. Diagrammatic horizontal section to show fascial planes.

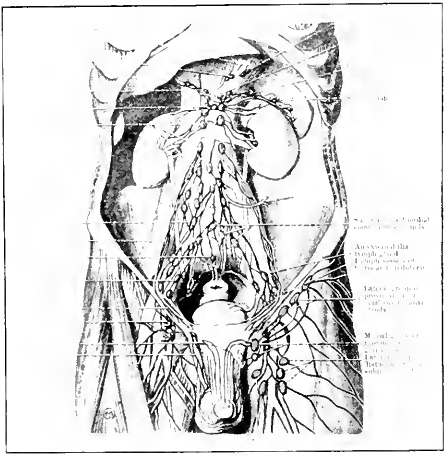


FIG. 3. Retroperitoneal Lymph Glands. (After Cunningham.)

vessels. A large bursa, the bursa iliopectinea, intervenes between the tendon of this muscle and the hip joint over which it runs.

The fascial planes play an important part in the determination of the course of the abscesses (Fig. 2). The kidneys are surrounded by the fascia renalis, which is open only on the infero-medial aspects, the anterior layer running from the peritoneal surface of one kidney across the midline, anterior to the aorta and the aortic lymph nodes, to join its mate on the other side. The posterior fascia fuses with the psoas and lumbodorsal fasciae. The last mentioned fascia has three layers. The anterior layer lies anterior to the quadratus lumborum and branches off medially into the psoas fascia in front of this muscle, and attaching to the prevertebral tissues, and another layer behind the muscle attaching to the transverse processes. The middle layer of the lumbar fascia lies behind the quadratus, and likewise attaches medially to the transverse processes. It is of significance that though the fascial planes at the level of the upper lumbar vertebrae are quite thin, in the lower portion, as the fascia iliaca, they become much thicker. (Spalteholtz.)

The lumbar lymph nodes (Figure 3), twenty to thirty in number, lie along the aorta between the level of the second lumbar vertebrae and

the bifurcation. There are a median row of four or five in front of and five or six behind, the aorta, over the bodies of the third and fourth lumbar vertebrae, and two lateral rows consisting of a number of nodes on the successive heads of the psoas muscle. On the right side a few nodes are distributed in front of the vena cava. These glands drain a large area. The median row receives the lymph from the descending colon and the mesocolon; the lateral rows drain the muscles of the posterior abdominal wall and the iliac nodes, which in turn drain the legs, the testes, ovaries, Fallopian tubes and uterus, and the kidneys and suprarenals.

ETIOLOGY.

A review of our cases shows the sources of the abscesses to be manifold. A suppurative myositis of the posterior abdominal wall, whether the result of a metastatic infection or the result of an infected hematoma following trauma, will find in the psoas sheath the course of least resistance for the discharge of its pus. Infections of the solid viscera can likewise be responsible for such abscesses. Thus, infections of the kidney, particularly those which are not very fulminating, and have their origin in the lower pole of the kidney, find but little fascial interference as gravity directs them to the psoas. Retroperitoneal infections originating in the hollow viscera, or having been produced by extension from infection of the peritoneum, are not uncommon, and while they have the entire tela subserosa to penetrate, often find their way into the wide end of the psoas funnel. Infections of the internal genitalia, when they produce pus, do not ordinarily discharge it through the upper psoas region because gravity is against this, yet, when under considerable tension, such abscesses can break through the lower thicker fascia, to course in the regulation manner. Pleural empyemata have gravity to help them, but because of the interposition of strong structures do not frequently act as the producing factor. The existence of primary gangrene of the retroperitoneal fat is reported by Eliot.[1]

Last but not least we are confronted with the condition of suppurative lymphadenitis. When one considers the vast area drained by these glands, and when one remembers how common infection of the lymph glands is, one is not surprised by the frequency with which these glands are responsible for psoas abscesses, or by the variety of conditions which produce abscesses through their medium. One realizes how frequently lymphadenitis exists if one studies the more superficial chains such as

1. Eliot, New York Presbyterian Hosp. Reports, 1897

the cervical glands. Because of the difficulty of observing and palpating the retroperitoneal glands, it is not easy to recognize an involvement of these glands unless they make themselves recognized through their effect on adjoining structures. Thus, when the infection of the lymph glands leads them to break down and produce pus, the suppuration will course down the natural path into the psoas sheath. One can see how metastatic infections from some distant focus may be responsible through the medium of these glands. Infections of the female genitalia, whether puerperal or non-puerperal, are frequent predecessors of the condition we are considering. The male genitalia, though naturally less frequently responsible, are nevertheless occasionally to be incriminated. Infections of the lower extremities have been found responsible through extension by the lymph channels.

Lumbar lymphadenitis of tuberculous origin, without any clinical evidence of primary involvement of the usual visceral sources, is relatively so common as to deserve special mention. We have repeatedly met cases of psoas abscess, previously classified as cases of Pott's disease (because of the recognition of tuberculous pus and the chronicity of the draining sinus), which on careful study and observation of the clinical course proved to be attributable to tuberculosis of the lumbar lymph nodes. Illustrative of this was patient G. S., who came to us, after having been treated for tuberculosis of the spine for one year, because of pain in the groin, a tuberculous psoas abscess, and a moderately rigid spine. Our repeated X-ray examinations showed no bony involvement. The sinus from the psoas abscess cleared up spontaneously in a few months. A year later the patient was engaging in rather severe exercise, such as prolonged horse-back riding, mountain climbing, etc., without any apparent spinal discomfort. X-ray again was negative for spinal involvement.

The organism which one finds in the abscess will naturally vary with the character of the initial lesion. Tuberculous lymphadenitis with suppuration will permit the isolation of the tubercle bacillus. In the more acute conditions, staphlococci, streptococci, and the other pus-producing organisms are found in various degrees of virulence. In our cases we have isolated streptococcus pyogenes, staphylococcus haemolyticus, stalphylococcus aureus, staphylococcus albus, B. coli, pneumococcus, and the tubercle bacillus.

COURSE OF ABSCESS.

Having found its way into the psoas sheath, the pus follows a definite course; that is, it travels downward towards the insertion of the iliopsoas muscle. Here no individual fascia exists; therefore, the abscess

collects near the pectineus and adductor longus muscles. After this the infection will travel one of several courses.[2] It may follow the superficial ramus of the middle circumflex femoris artery and point just medial to the psoas muscle. More commonly the pus enters the adductor triangle and points in the inner upper third of the thigh. Other courses are: a—dorsally along the circumflex femoris medialis artery, about the adductor minimus and quadratus femoris under the gluteal fascia to present itself dorso-laterally under the skin; b—along the sciatic nerve through the greater sciatic notch as an ischio-femoral abscess; c—under the iliacus fascia to appear just below Poupart's ligament, or occasionally to break into the sheath of the quadratus lumborum, then up the lumbo-dorsal fascia to present in Petit's triangle (Figure 4). It is quite conceivable that some abscesses will undergo resolution and spontaneously clear up. We have several cases which would fit into this group.

2. Loeffler, F., Ztschrft. für orthopädische Chir., XL., ii, July, 1920.

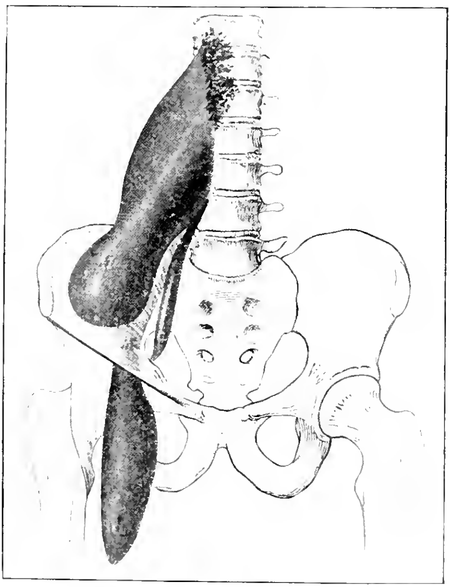


FIG. 4. Types of Psoas Abscesses. (After Loeffler.)

SYMPTOMATOLOGY.

The story that the patient brings, as a rule, falls into one of two general classes. In one group of cases the patient comes to us complaining of his "leg drawing up," or "limping on one side." On questioning one frequently elicits the history of an antedating injury. Following the trauma there is usually a latent period with gradual onset of vague symptoms of discomfort in the lower spine. sometimes becoming severe enough to be called real pain.

Not infrequently the symptoms referable to the back are entirely absent, and attention is first attracted by the appearance of an abscess or the drawing up of a leg. There may be some concomitant loss of weight, possibly some night sweats, and in some cases there may even be an afternoon rise of temperature. Pain in the thigh as low as the knee may be complained of.

On the other hand, there is a group of cases in which the patient is brought in acutely ill, usually unable to walk. The patient presents the usual signs of a septic condition, and seems to be suffering exquisite pain in the region of the lower back, hip, thigh, or knee on the affected side. Questioning may reveal the fact that three or four weeks previously the patient had a mild infection associated with an operative condition on the genito-urinary tract. Thus, a prostatectomy, an induced abortion, or a delivery may have been responsible for the infection at that time. Occasionally, one obtains a history referable to the gastro-intestinal tract or even to an abrasion on the leg. In some of our cases the local condition seems to have followed such general infections as scarlet fever. But whatever the symptoms may have been preceding the immediate condition, the symptoms of pain in the sacro-iliac region referred down the thigh to the knee and the deformity of the hip with the inability to walk are usually common to all.

PHYSICAL EXAMINATION.

On examining the cases one finds the following signs common to most of them: flexion deformity of the hip joint, *limitation of hyper-extension*, but freedom of abduction, adduction, rotation, and further flexion. With the patient standing, there is found considerable apparent spinal deformity, which, however, clears up in great part when the patient is

placed in a sitting position. There may persist a slight amount of lateral deviation of the spine, a "C" curve with the concavity on the affected side. With the patient in this position it is found that there is relatively free motion to the spine in all directions. Palpation and percussion of the spine produce no pain. Pressure, however, over Petit's triangle and over the sacro-iliac joint of the diseased side at times produces pain.

Abdominal palpation will often reveal some slight muscle spasm beneath which, in the lower lateral quadrant, it may be possible to distinguish an abnormal mass sensitive to pressure and frequently cystic in character. Pressure over this may produce pain referred to the knee. Examination of the knee reveals no pathology. In the more advanced cases the patient will demonstrate a tumor mass pointing in the groin or in one of the other favorite sites mentioned above. It may be possible by compression of these lower tumors to make them disappear, only to have them reappear when the pressure is removed.

In the acute cases in addition to the above symptoms one finds all of the objective findings referable to the febrile state.

The X-ray examination is of great assistance but a word is necessary with reference to the interpretation of the radiogram. Examination of the spine in the antero-posterior and more particularly in the lateral views will be negative for bone involvement. In interpreting X-rays of the hip and sacro-iliac joints one must be very cautious not to be misled by the hazing of the joints due to the super-imposition of the abscess over the joints. This mistake is very easily made, the writers having seen such hips reported "acute infection of the hip joint" by the very best X-ray diagnosticians. It is unnecessary, of course, to mention that shadows over the ilium are frequently due to intestinal contents.

DIFFERENTIAL DIAGNOSIS.

The difficulties that one encounters in differential diagnosis will be recognized when one observes that our cases were variably diagnosed by good clinicians as arthritis of the hip, arthritis of the sacro-iliac joint and spine, Pott's disease, trauma of the spine, tuberculosis of the hip, femoral hernia, tumor of the thigh, broad-ligament abscess, pelvic inflammatory disease, and sciatic neuritis.

The differentiation of hip infections from psoas abscess is often quite difficult. In both, one finds a limp, and in both the leg is held in abduction, external rotation, and flexion. The keynote of the differentiation lies in the ability in psoas abscesses to move the hip through an

arc of motion without severe pain, *if the hip is flexed;* whereas one generally finds limitation of motion in the hip joint in any arc of motion when the hip joint itself is diseased. In psoas conditions one does not find a persistent contraction of the adductors, as one is apt to note in hip involvements. Furthermore, in the chronic conditions, such as tuberculosis, the atrophy of the thigh in psoas conditions is slight, whereas in hip conditions it is quite pronounced. Usually in psoas abscesses one will not find sensitiveness on local pressure on the posterior surfaces of the hip or on centripetal compression of the trochanters, such as one often notes in hip conditions. Again, the pains in hips are referred to the front of the knee, whereas, generally in psoas conditions the pains are felt in the lower lateral back, radiating down the thigh, forward and downward.

Other conditions of the hip can easily be ruled out by the usual measurements which in psoas conditions will be found to be normal.

Spinal conditions are more easily eliminated. Have the patient sit on the edge of the bed or table and test the spine for mobility. A spinal lesion severe enough to produce an appreciable abscess will produce much more limitation of motion than is found in cases of non-spinal psoas abscesses. Herniae or tumors of the thigh can be thought of only in advanced cases, when the abscess is already pointing, at which time the location of the infection, the sense of fluctuation, and the compressibility can differentiate the conditions. The usual pelvic conditions can be recognized by pelvic examination, and when the existence of the psoas lesion is borne in mind should offer no difficulty.

Osteomyelitis of the sacro-iliac joint, a rare condition, is not to be diagnosed merely on the appearance of a shadow over the ilium. Involvement of the sacro-iliac joint, it will be recalled, is usually associated with limitation of motion in the spine. In the presence of psoas abscess, the normal sacro-iliac joint behind the fluid may appear hazy on X-ray, or, from the distortion of the pelvis incident to the hip deformity, may appear different from the joint of the healthy side. Extreme caution must be observed before incriminating either of these structures.

The recognition of the factor behind the psoas abscess will depend on two points, first the history, and second the process of elimination. A recent pregnancy, abortion, or miscarriage, particularly when followed by a febrile condition, must always be considered with suspicion if a psoas abscess develops. Symptoms of an antedating pyelitis will incrim-

inate the kidney. A concomitant sore throat will lead one to look for the primary focus in the infected tonsils. Gastro-intestinal symptoms usually precede psoas abscesses of gastro-intestinal origin. A recent injury to the back will suggest an infected hematoma.

TREATMENT.

Treatment of the condition will vary with the character of the infecting organism, and the size and location of the abscess. Puncture of the abscess by needle for the purpose of evacuation or diagnosis has been described by Calot. When the abscess is superficial, treatment is simple. When the abscess is small, however, and has not presented any visible tumor, it can be reached by inserting the needle just above the middle of the proximal half of Poupart's ligament upward and backward at an angle of twenty-five degrees (Figure 5). Evacuation of the abscess is reported by vaginal puncture. For careful surgical approach and examination, however, it is necessary to do a more elaborate dissection. An incision is made over the crest of the ilium, from the anterior superior spine backward a distance of eight cms. The incision is carried through the external and internal oblique muscles and transversalis fascia to the peritoneum, which is then stripped forward to expose the psoas

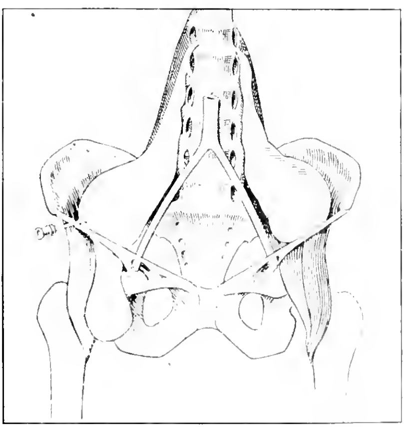


FIG. 5. Aspiration of Psoas Abscess. (After Calot.)

muscle. Through this incision, examination can be made from as high as the kidney to as low as just beyond the linea terminalis. Treatment of the abscess will then follow accepted surgical principles—drainage in cases of septic infections, and evacuation and closure in cases of tuberculous lesions.

As a rule, after evacuation of the abscess, the hip deformity clears up. The septic infections will drain for a while and then close. The tuberculous sinuses drain much longer, but the condition does not have the serious prognosis associated with infections of the spine.

SUMMARY.

In conclusion, we desire to call attention to the facts, first, that there exists a large group of cases of psoas abscesses which originate from sources other than spinal or pelvic bone involvement; second, that lymphadenitis of the retroperitoneal lymph glands exists with either a tuberculous or a septic organism as the infecting agent; and third, that these conditions are to be clearly differentiated from spine or hip involvement.

Book Reviews

A Manual of Corrective Gymnastics. By LOUISA C. LIPPITT. New York: The MacMillan Company, 1923.

The author says in the preface of her book, "With the increasing demand for corrective gymnastics in the schools as well as in the colleges, it has become necessary to stress more and more this branch of physical education in the training of instructors for this work." . . . "In my own work as director of corrective gymnastics for girls in the University of Wisconsin, I have felt the need of a book which would give exercises for the many types that are treated in a corrective gymnasium and which could be used both as a text book and as a reference book."

The author has adhered very closely to her plans throughout the book, and anyone reading it will get many very helpful suggestions. Chapter 4—Giving Physical Examinations and Assigning Students to Classes; Chapter 5—Corrective Exercises in Classes and with Individuals; Chapter 6—Corrective Exercises for Small Children and Older People, and Chapter 7—What is Correct Posture and Why is it Necessary? will give anyone an excellent plan upon which to build up his work in this line.

Pathological Physiology of Surgical Diseases. By PROFESSOR DR. FRANZ ROST, University of Heidelberg. Authorized Translation by STANLEY P. REIMANN, M.D. Philadelphia: P. Blakiston's Son & Co., 1923.

The authors are to be congratulated on presenting this unique volume correlating these two fundamental sciences.

It is of great value to the general surgeon, physiology being our greatest ally in the management of surgical cases before and after operation. The book being a careful compilation of the experimental literature with a very complete German bibliography makes it particularly helpful to the teacher of surgery.

The upper class students and hospital internes will now find the answer to many questions that are constantly occurring to them during their hospital rounds, as the translator's clear diction and his added notes from American and English, as well as more recent foreign, literature bring the work fairly well up to date, and gives a concise idea of the amount of experimental work necessary to establish facts concerning physiological changes necessary to bring about known pathological lesions.

There is one chapter on the extremities which should be of interest to the orthopaedic surgeon.

News Notes

With the deepest regret we announce the death on Friday, May 11th, of Dr. William G. Erving, of Washington, D. C., a member of the American Orthopedic Association since 1908.

The programme of the fourth regular meeting of the Chicago Orthopaedic Club, held on the evening of May 11th, 1923, was as follows:

Bilateral Sacro Iliac Obliteration.—Dr. S. C. Woldenberg.
Radius Curvus (Madelung's Deformity).—Dr. Beveridge H. Moore.
Some Orthopaedic Conditions of the Knee Joint.—Dr. Charles A. Parker.

For those who wish to study in France this summer, it is announced that Dr. Hallopean will give a course of clinical instruction consisting of ten lessons on non-tuberculous affections of the osseous system in children. This course will be given from the 2nd to the 13th of July, at the Hopital Trousseau, Paris, and will be followed by a course at Berck, between the 16th and the 29th of July, given by Dr. Sorrel and other members of the Maritime Hospital.

Further information may be obtained by writing to Dr. Parin, Hopital Maritime, Berck-Plage, (P. de C.), France.

The Section in Orthopedic Surgery, New York Academy of Medicine, met on the evening of March 16th.

The following programme was carried out:

PRESENTATION OF CASES. From the Hospital for Joint Diseases.
(a) Cases of Köhler's disease. Albert L. Levy (*by invitation*).
(b) 1 Club feet. 2. A new operation for bow-legs. Henry W. Frauenthal.
(c) Wrist tumor; operation; findings. Samuel A. Jahss (*by invitation*).
(d) Post encephalitic hemiplegias. Charles Rosenheck (*by invitation*).
(e) Pathological fractures through bone cysts. Harry C. Stein (*by invitation*).
(f) Neurotrophic disturbances of bones and joints. Harry Finkelstein.
(g) Interesting x-ray plates. Herman B. Philips (*by invitation*).
(h) Cases illustrating the paper of the evening. Angelo L. Soresi.

PAPER OF THE EVENING. "The open reduction of fractures, without the help of any foreign body." Angelo L. Soresi.

At another meeting, on April 20th, the programme was as follows:

PRESENTATION OF PATIENTS AND REPORTS OF CASES. (From Fordham Hospital.)
(a) Bone grafts (5 cases) Alexander Nicoll.
(b) Severe infectious monarthritis (4 cases); osteomalacia; Sarcoma of the fibula. Samuel W. Boorstein
(c) Radiographic plates of interesting bone cases. Isidore J. Landsman (*by invitation*).

PAPER OF THE EVENING. "A practical consideration of the union of fractures." Illustrated with lantern slides. Edwin W Ryerson, of Chicago (*by invitation*).

On the evening of May 18th, the following programme was presented:

PAPERS:
(a) "Fracture of the anterior superior spine." Louis Carp.
(b) "Treatment of bone abscess by evacuation through a small drill hole." Walter M Brickner.
(c) "The operative treatment of old congenital dislocations of the hip." Illustrated by lantern slides. A Bruce Gill, of Philadelphia (*by invitation*)

Dr. Alonzo Myers, of Charlotte, N. C., announces that henceforth Dr. J. Stuart Gaul will be associated with him in the practice of orthopædic surgery.

The Eastern States Orthopædic Club met in Pittsburgh on May 11th and 12th, 1923.

The clinics were well run and of great value. They were attended with interest and aroused beneficial discussion.

The following programme was presented:

CHILDREN'S HOSPITAL—FRIDAY, MAY 11, 9 A. M.

Tuberculosis of spine:
1. Demonstration of frame treatment.
2. Demonstration of cast.
3. Demonstration of brace.
4. End results of treatment.

End results of sarcoma of spine after operative removal.
Demonstration of scoliosis brace.
End results of open operation congenital hip.
Infantile paralysis:
1. Transplantation of peroneals to dorsum foot.
2. Stabilizing operation on talipes equino-varus.
3. Stabilizing operation on completely paralyzed flail foot.

Dr. Wallace, Dr. Markell.

MERCY HOSPITAL—FRIDAY, MAY 11, 2 P. M.

Syphilitic aortitis. Dr. Ritchey.
Surgery of blood vessels, with report of successful suturing of femoral artery. Dr. Seiber.
Relation of focal infection to arthritis. Dr. Lichty.
Synovectomies and bursectomies. Report of 2 cases. Dr. Wallace.
1. Fractures of pelvis.
2. Fractures of bones of forearm. Dr. Well.

Internal derangements of knee joint. Dr. Wallace.
End results of crush fractures of spine. Dr. Wallace.
Arthroplasties:
(*a*) Results. (*b*) Problems of ankylosis of hip. Dr. Wallace.
Ward Rounds.

CLINIC FOR EASTERN STATES ORTHOPÆDIC CLUB—ALLEGHENY GENERAL HOSPITAL, 8.45 A. M., MAY 12, 1923.

Operative treatment of hallux valgus. Drs. Silver, Steele and Yount.
Observations in European clinics, with especial reference to prosthesis. Dr. Yount.
A statistical study of operative and non-operative results in spinal tuberculosis Dr. Steele.
(*a*) Method of gradual correction of loss of hip flexion.
(*b*) Method of treating fracture of clavicle.
(*c*) Clinical experience with the Willems' treatment of infected joints. Dr. Mooney.

A few observations on the treatment of tuberculosis of the hip. Dr. Silver.
Statistical report on osteomyelitis. Dr. Steele.
A study of the value of artificial limb suspender control in infantile paralysis Dr. Yount.
Methods used in the treatment of industrial fractures. Dr. Alexander.
Experimental encephalitis with the virus of herpes labialis: a preliminary report Drs. Goodpasture and Teague.
Exhibit of orthopædic instruments, splints and equipment

Current Orthopaedic Literature

SECONDARY OS CALCIS. Arthur Krida, M.D. *Journal American Medical Association*, March 17, 1923.

CONGENITAL DEFECTS

Dr. Krida reports a case of secondary os calcis of the right foot of a man of 30 who suffered from recurring sprained foot. The skiagraph seemed to show a fracture of the anterior processus calcanei, but at operation he found a rudimentary os calcis across the middle of the calcaneo-cuboid ligament above the ligaments and upon the dorsum. He quotes Dwight, Pfitzner and other investigators of the subject. The paper is illustrated with two half tones. His conclusions follow:

CONCLUSIONS.

From the clinical standpoint, the separate ossicle described by Pfitzner may be accepted as the typical secondary os calcis. Its occurrence in 2 per cent of his large series of dissections need not lead to the expectation of finding it frequently in routine roentgenograms of the foot, as the smaller and less well developed specimens might easily escape demonstration.

It would seem that a well developed secondary os calcis, acting like a wedge in a series of complicated movements in the middle of the tarsus, would be peculiarly liable to avulsion or displacement.—*H. A. Pingree, M. D., Portland, Me*

CONGENITAL DISLOCATION OF THE HIP, WITH INTRACAPSULAR EXOSTOSIS. Carroll D. Storey. *Journal American Medical Association*, March 31, 1923, page 914.

This is a case report of a girl, aged 13, who had suffered from a limp since walking commenced. Relief was not sought until the child was 11 years old. There was $1\frac{3}{4}$ inches of shortening. Clinical diagnosis was congenital dislocation of the hip. X-ray examination confirmed this and showed in addition a large exostosis projecting from the under surface of the neck of the femur.

Operation by anterior route disclosed an exostosis $1\frac{1}{2}$ inches long and $\frac{3}{4}$ inch thick at its narrowest part. The growth was entirely intracapsular. The

exostosis was removed and an attempt was made to reduce the hip, but was unsuccessful. The wound was closed, heavy traction was applied for three weeks, and the dislocation reduced with the aid of the Bradford machine. The final outcome was that the "hip is practically stiff in 25 degrees of flexion and 15 degrees of outward rotation. The patient is able to walk without fatigue and without pain." So far as the author knows this case is unique. —*Alexander Gibson, F.R.C.S., Winnipeg.*

CORRECTION OF CONGENITAL CLUB FOOT. E. H. Bradford. *N. Y. Med. Jour. and Med. Record*, Feb. 7, 1923.

After correction of club foot deformity the pressure on the sole in walking should be normally distributed, not chiefly upon the fifth metatarsal. After correction a shoe with a thick wedge under the cuboid helps to correct such a tendency. Permanency of cure of club foot is attested by cases treated twenty and thirty years ago.

After referring to various methods of treating neglected club foot, the author describes a procedure using an osteotome for severing the internal lateral and astragalo-scaphoid ligaments subcutaneously, likewise; in some cases, the calcaneo-cuboid ligaments, together with wrenching and Achilles tenotomy. Some cases require a two stage procedure.—*R. W. Billington, M.D., Nashville.*

NON-TUBERCULOUS ARTHRITIS

EXERCISE IN ACUTE INFECTIOUS ARTHRITIS. S. W. Boorstein. *N. Y. Med. Jour and Med. Record*, Feb. 7, 1923.

This applies to acute cases which later become chronic. Causative infectious foci are to be removed when possible. Treatment should begin early while redness and swelling still exist. The joints are usually put in plaster splints for about ten days, then baking, massage, and exercise are begun together with occupational therapy under the direction of a trained attendant. The patient should be out of bed as soon as possible. Persistent effort and encouragement are needed. Lasting pain and swelling after exercise show that the joint has been over-used. Three cases are reported.—*R. W. Billington, M.D., Nashville.*

ON A MANNER OF ONSET OF CHRONIC VERTEBRAL RHEUMATISM. Bufnoir and Legras. *Revue d'Orthopédie*, September, 1922, p. 429.

Case 1. Woman, age 27. Pain in back beginning in 1915 and increasing until April, 1918, she had to have a plaster jacket put on. Improved with rest so that in October she could go without the jacket, but pain came on again

and she had to have another jacket in January, 1919. Tenderness and pain in mid-dorsal region, but no kyphosis. Jacket removed in May, but had to be put on again. Pain was ameliorated by heliotherapy. Roentgenogram showed small loose bodies on the anterior border of the vertebral column, one each at the VI, VII, VIII, and IX dorsal intervertebral space. These bodies were symmetrical in shape and of the same density as bone. Patient had to keep wearing a celluloid jacket, but was able to work.

Case 2. Man of 42. Diagnosis of Pott's disease had been made. Pain and tenderness IV D to VIII D vertebra. Had typhoid at 28. A swelling developed on the left forearm which was opened and a small sequestrum extracted. Spine ultimately became stiff. Roentgenogram showed detached bodies on anterior border of bodies at the V, VI, and VII dorsal intervertebral spaces. After these findings and clinical course a diagnosis of infectious arthritis was made. Improved under heliotherapy and rest. Able to go back to work after a year and a half.

Case 3. Man of 62. Constricting pain at level of last ribs. History of lues, but negative Wasserman. Parathesia of sphincters. Obtuse kyphos in dorsal region. Roentgenogram showed narrowing of VII and VIII dorsal vertebral bodies and of spaces between V, VI, and VII D. Osteophytic lipping on anterior margins of these vertebrae and a detached small body of bony density between VIII and IX D. Unable to walk without support. Marked improvement with rest, heliotherapy, and arsenobenzol.

Case 4. Woman of 34. Came to Cannes in a plaster bed, with a diagnosis of Pott's disease. Sharp pain along entire spine. No kyphos. Negative roentgenogram except for a small detached osseous body at the anterior superior border of VII D. Because of character of pain and roentgenographic findings the diagnosis of Pott's disease was abandoned. Improved with rest and heliotherapy.

Case 5. Woman of 37. Sharp pain in back coming on rather suddenly and lasting several weeks, followed by dull pain. Another sharp attack six months later. Roentgenogram showed an opacity in the space between IX D and X D. Patient had pulmonary tuberculosis but spinal condition was not tubercular.

These cases show that infectious arthritis may simulate tubercular spondylitis. But when carefully analyzed it is found that the pain is sharper than in tuberculosis and the roentgenogram is different. Free ossified bodies are frequently found in addition to lesions in the body of the vertebra. The prognosis is not bad. Most cases improve sufficiently to return to work in one to two years. Some flexibility may return in the spine.

The only unusual thing about these cases is the presence of the detached osteophytes.—*William Arthur Clark, M.D., Pasadena, Calif.*

A CASE OF SEPTIC ARTHRITIS IN AN INFANT. A. MacKenzie Forbes. *Canadian Med. Assoc. Journal*, Feb., 1923, p. 118.

This is a case report concerning a baby three weeks old, suffering from a swelling in the upper half of the left thigh. The baby was breast fed, and

had been restless for three or four days, but not feverish. A large, tense swelling was present, the skin over it of a purplish-red hue, with vesicles increased in number and dilated. Fluctuation was not elicited, though the tumor suggested a deep seated collection of fluid. A haematoma arising from an angioma was thought likely, there being no evidence of infection through the navel or respiratory tract, and no elevation of temperature. Exploration by needle followed a sudden rise in temperature and pulse. Pus was found and evacuated freely by deep incision, but the baby died in a few days from septicaemia. The seat of infection proved to be the hip joint. Septic arthritis, as in this case, usually begins about the second or third week, and about 75% of the cases die of septicaemia, even when thoroughly drained.—*J. A. Nutter, M.D., Montreal.*

Chronic Infectious Arthritis. Ralph A. Kinsella, M.D. *Journal American Medical Association*, March 10, 1923.

Dr. Kinsella has given us a paper that is rather confusing and one which it is impossible to sum up in an abstract. He has, however, seen clearly a good many points to which not much attention is paid, and has frankly stated them. His comment follows:

COMMENT.

The most significant features of this study have been:

1. The emphasis given to the part which circulatory changes and consequent nutritional changes play in the production of painful stiffening of the joints in which simple atrophy is the only evidence on roentgen-ray examination.

2. The importance of exhaustive physical examination in the search for infected foci.

3. The necessity of employing many forms of treatment, since no form was constantly successful and each kind of treatment was occasionally successful.

4. The importance of the last described group of male patients whose chief symptom is backache and who have spinal osteoarthritis, apparently associated with prostatic infection.

5. The lack of evidence that arthritis deformans is a focal infection.—*H. A. Pingree, M.D., Portland, Maine.*

NEOPLASMS.

An Unusual Foreign Body in the Knee Joint. Jean Madier. *Paris Médical*, November 25, 1922, p. 471.

A case is reported as follows:

Boy of 12 had a fall on his knee, which made a wound just under the patella. This happened in July, 1918. The knee was immobilized for a month and there was evidently no infection of the joint. Roentgenogram showed nothing abnormal and the child was permitted to walk. For the next two years he had several periods of trouble with the knee, during which there was pain, swelling,

and limitation of motion. Examination in March, 1921, showed muscular atrophy in the affected leg, fluid distension of the joint, incomplete extension and flexion. Roentgenogram then showed a foreign body slightly more opaque than the bone lying over the anterior spine of the tibia. The case went on with more or less trouble until January, 1922, when the child was brought to the hospital again. The foreign body was then palpable over the internal condyle, where it made a visible bulge on the surface. Roentgenogram showed that it had shifted its position from near the center of the joint. Operation for removal was done and the foreign body was found to be a piece of glass. Recovery was uneventful. Five months after the operation the patient had had no more trouble, could extend the leg very well, and could walk and run without hindrance.

The salient points brought out in this case are: (1) There was no general infection of the joint at the time the glass penetrated it. (2) The joint tolerated a piece of glass with sharp edges for two years and a half. Foreign bodies which are retained so long a time are usually lead or other smooth pieces. (3) It was not possible to determine the nature of the foreign body by roentgenography.—*William Arthur Clark, M.D., Pasadena, Calif.*

Myeloma of the Vertebræ. Robert B. Osgood. *Boston Med. and Surg. Journ.*, March 22, 1922.

Dr. Osgood calls attention to this unusual tumor on account of its occasional simulation of the more common diseases of the spine,—in particular, tuberculosis,—and emphasizes the need of such a presentation by the fact that the ante-mortem diagnosis of myeloma was made in only one of the three cases reported by him. All cases had pain in the back as a predominating symptom and when x-rayed showed diminished density of a few to several of the dorsal and lumbar vertebrae, with partial collapse of some, but with very slight kyphos.

Brace treatment, as in tuberculosis, improved them for a time, and in one a bone graft was inserted with temporary relief. Other bones became affected, with fractures of the femora in one and circumscribed areas of softening in the skull of two others. The duration of back symptoms in one was two years, in another six years, and in a third, four years. This patient was still living when this report was made. Bence-Jones protein test was positive in only one of the three. No specific treatment is mentioned, though protection of the spine as in caries is indicated.—*C. A. Parker, M.D., Chicago.*

Cysts of the External Semilunar Cartilage of the Knee. D. B. Phemister. *Jour. A. M. A.*, March 3, 1923, p. 593.

Two cases are reported with a careful pathologic examination in each case. The pathologic findings in these cases are identical with those of colloidal cystic swellings which develop in various connective tissues, such as come on the back of the wrist, and are commonly called ganglions. Most of the cases

occur in young adults and more in males than females. Trauma plays a slight role in these cases. The lesion has never been observed in the internal semilunar cartilage. Treatment consists in operative removal of both cyst and external semilunar cartilage. When only the cyst is removed there is usually a return of symptoms and a secondary operation is necessary.—*Edward S. Hatch, M.D., New Orleans, La.*

FRACTURES, DISLOCATIONS AND OTHER TRAUMATA.

FRACTURES OF THE THIGH IN CHILDREN. Rene Bloch *Revue d'Orthopédie*, September, 1922, p. 447.

Fracture of the femur is more common in boys than in girls, 410 to 129. Bilateral fracture was found in only six cases out of 537. Left femur 299 times to 240 on the right.

The mechanism may be direct violence, bending, jamming, or torsion. Direct violence is a frequent cause, usually from running against an obstacle or being run over by a vehicle. Flexion fractures are produced by a fall on the knee or foot which bends the thigh forward, breaking the femur. Longitudinal jamming of the bone may produce a rather rare telescoping fracture. Torsion fractures are oblique and are the most common. The usual mechanism is a fall with leg turned outward (sometimes inward) the weight of the body twisting the femur, the lower end of which is fixed by the position of the leg on the ground.

The fracture may be sub-periosteal, such as the telescoping fracture, but in the incomplete or "green-stick" type the periosteum breaks on the convex side.

Subtrochanteric fractures are rare in children. The break is usually in the middle third or at the juncture of the middle and upper thirds.

The oblique type is quite common, 115 cases in 157. There is always overriding with the proximal fragment anterior and sometimes adducted, due to muscle pull. A third fragment, triangular in shape, is often found but it does not complicate the union.

Formation of callus is much more rapid in children than in adults. Good immobilization makes for good development of the callus; it will form without immobilization, but it becomes excessive and may interfere with function.

In diagnosis, there is usually not much chance for error in a complete fracture of the femoral shaft. With the patient lying down, the leg lies in external rotation and there is usually more or less antero-external bowing of the thigh. A good method of examination is to place the hand, palm up, under the thigh and make upward pressure. Abnormal movement and crepitation can thus be noticed. Ecchymosis may be present and may serve as a valuable diagnostic sign in green stick fractures.

Subperiosteal fractures do not show deformity or shortening. Such a fracture may be discovered by eliciting a definite point of tenderness on deep palpation by testing the flexibility of the bone and by roentgenogram in two planes. Green stick fractures show bowing but no shortening.

The prognosis of these fractures in children is excellent. Union takes place in about a month. There remains very slight, if any, shortening, or the broken femur may even be a trifle longer than the sound one if a rachitic curve is present. Late results are equally good. A femur which may have had slight bowing deformity becomes as straight as the good femur in a few years, and excess callus disappears.

Simple extension is the best method of treatment. The vertical extension commonly used in America is deemed unnecessary.—*William Arthur Clark, M.D., Pasadena, Calif.*

MYOSITIS OSSIFICANS TRAUMATICA. Dudley Carleton. *Boston Med. and Surg. Journal*, March 22, 1923.

Carleton reports two cases occurring in a large surgical experience of over 25 years, the small number thus attesting their rarity.

One of these extended forward from the coronoid into a hematoma following a severe injury, and the other developed in the substance of the adductor longus muscle after an injury accompanied by a large ecchymosis had occurred in the right groin. He believes with Painter in a recent article that their origin "is that of periosteal transplant and liberated osteoblasts caused by the rupture of muscle attachment from bone, with the tearing off and retraction of periosteum into the muscle structure."—*C. A. Parker, M.D., Chicago.*

THE SO-CALLED RAILWAY SPINE. F. Walter Carruthers. *Southern Med. Jour.*, March, 1923, p. 216.

The anatomic relations of the spine are taken up and the skiagraphic and physical findings discussed, and a plea is made to correlate these. A careful examination and skiagraph of all cases of back trouble in industrial cases should be on record as a check on future trouble.

One case of fracture of the 12th dorsal vertebra is reported.—*Edward S. Hatch, M.D., New Orleans, La.*

CHRONIC NON-INFLAMMATORY LESIONS OF THE KNEE JOINT. M. S. Henderson. *Archives of Surgery*, January, 1923, p. 118.

After discussing the anatomy and physiology of the knee joint, the following lesions are discussed. (1) Sprains. Here the internal lateral ligament is generally involved. Damaged semilunar cartilage is ruled out by absence of locking. Rest for a few days, baking, and massage are usually effective. If pain and tenderness persist, the inner side of sole and heel should be raised to remove the strain from the internal lateral ligament. (2). Ruptures of the crucial ligaments. This condition would seem to be infrequent. In the

few cases seen by the writer, excellent function has been obtained by the use of a plaster-of-paris cast in a slightly flexed position. (3). Intra-articular fractures of the knee joint. Severe trauma may produce fracture of the tibial tuberosities or of the femoral condyles. Very little can be done for such patients. The condition of disability is usually not severe enough to warrant an ankylosing operation. When seen early such cases should be treated by early motion, which is less painful when carried out under extension. It is doubtful whether an early open operation would secure better position of the fragments. (4). Recurring dislocations of the patella. These are always outward. Reefing the inner capsule after lengthening the outer capsule acts satisfactorily. The condition is most commonly seen in women. (5). Old ununited fractures of the patella. These are difficult to treat. The disability may be great or but slight. The fragments must be brought together without tension, even though the upper fragment is dissected entirely free and used as a graft to the lower. The gap left is obliterated by sutures, the fragments are held together by beef bone screws, kangaroo tendon, or wire. (6). Intrinsic mechanical derangements of the knee joint. Of these, the internal semilunar cartilage is the principal source, the loop or bucket-handle type of tear being most frequently seen. The external semilunar, thanks to its loose attachment at the periphery, usually escapes injury. Reduction by manipulation of a displaced cartilage is described, also the operation for its removal. Another source of mechanical derangement is the presence of loose osteocartilaginous bodies. These are produced by three conditions: 1, osteochondritis dissecans; 2, hypertrophic arthritis, and 3, osteochondromatosis. Osteochondritis dissecans rarely sets free more than one or two bony masses, usually from the internal condyle near the insertion of the posterior crucial ligament. The etiology of this condition is not yet clear. In hypertrophic arthritis, loose bodies are produced by the breaking off and dropping into the joint of marginal outgrowths. These wander about and increase in size; four or five may be present, normally in elderly persons. In osteochondromatosis the synovial membrane, from some developmental defect, takes on the property of forming osteocartilaginous bodies, which may reach a large number. We do not know why this occurs. The presence of loose bodies of any origin is an indication for their removal. Often this can be done under local anaesthesia. When the bodies are multiple the split-patellar route is the method of choice.—*J. A. Nutter, M.D., Montreal.*

FRACTURE OF THE HEAD OF THE FEMUR, WITH DISLOCATION ON THE DORSUM OF THE ILIUM. Guy Hinsdale. *Jour. A. M. A.*, Feb. 17, 1923, p. 469.

Reported on account of the rarity of fracture of the femoral head. A woman of 55, weight 160 lbs., fell, striking her hip in an extreme position of the limb. After the accident the deformity typical of dorsal dislocation of the hip was present, with about three inches of shortening. Efforts to reduce the hip by manipulation proved ineffectual. X-rays showed one-third of the head of the femur, including, it was found later, the insertion of the ligamentum teres, lying on the lower acetabular margin. The dislocation was reduced

by open incision, the fragment first being removed. Recovery was prompt and satisfactory. The author discusses the possible mechanics of the fracture-dislocation, considering it likely that the leg was at first forced into an abnormal position and then by a fall the head was broken against the acetabular brim, permitting full dislocation.—*J. A. Nutter, M.D., Montreal.*

INJURIES TO THE CRUCIAL LIGAMENTS AND AVULSION OF THE TIBIAL SPINE. Charles F. Painter. *Boston Med. and Surg. Jour.*, Nov. 30, 1922.

Knee joint surgery has advanced rapidly during the last twenty years. Surgeons no longer hesitate to open and explore a clean knee joint, when correct surgical technique is available. The author lays stress upon the extraordinary stability of the knee joint mechanism and the way in which that stability is secured. He describes briefly the anatomy and the physiology of the joint, and then gives a description of four cases under his own care, the first three having torn one or both crucial ligaments, and the last one having a fracture at the base of the spine of the tibia. The first and fourth cases were treated conservatively, the second and third were operated upon. The results in all four cases were satisfactory. The author then gives a most valuable abstract of all available reported cases of torn crucial ligaments and fracture of the tibial spine, with particular reference to the methods of treatment employed and the outcome of these treatments. The following conclusions are reached:—Ruptures of the crucial ligaments are not as serious as they were at one time thought to be. Serviceable joints may be expected and the operative risks are small. Tunneling operations and transference of muscles or transplants of fascia are rarely called for. The median patellar incision gives the best exposure of the joint. A "cage" splint as a protection must be worn for several months after walking is begun. Avulsions of the tibial spine are best treated conservatively, a plaster cast with the leg in complete extension. If the contours of the articular surfaces of the femur and tibia have not been disturbed by the injury a good functional result may be expected.—*Walter G. Elmer, M.D., Philadelphia.*

CONCERNING A CASE OF PARTIAL FRACTURE OF THE TIBIAL SPINE. H. L. Rocher. *Revue d'Orthopédie*, September, 1922, p. 469

Three types of this lesion are recognized: (1), avulsion of the tibial spine; (2), fracture of the external tubercle; (3), wound of the tibial spine combined with fracture of the tuberosity.

In 1000 cases of fracture Kurlander found only three cases of fracture of the spine of the tibia. He regards it as a rare fracture caused by indirect violence through sudden, sharp pull on the crucial ligaments. His treatment consists in complete extension of the knee under anasthetic and immobilization for eight to ten weeks, followed by massage. If blocking occurs, the knee is opened through longitudinal patellar incision and the obstruction removed.

Tanton describes total and partial fractures of the tibial spine.

Such a case is reported under the above title by Rocher as follows:

A soldier fell from his horse in December, 1916, landing on one foot. Voluminous hemarthrosis of the knee occurred and was punctured. First seen by the author in July, 1917. No swelling. Pain and limping. Flexion limited to 140 degrees, extension to 155. Sharp pain on attempt to pass these limits. No lateral laxity when in extension, but some on flexion. Roentgenogram showed partial fracture of tibial spine including a quadrilateral fragment of the internal tubercle which was slightly tilted upward and backward. In order to walk, the patient stiffened his entire lower leg, otherwise the knee would rotate inward due to laxity of the crucial ligaments. He was advised not to have any operative interference, since consolidation seemed to be complete. With a brace holding the knee in as much extension as possible he was able to go back into service.—*William Arthur Clark, M.D., Pasadena, Calif.*

FRACTURE OF THE SPINE OF THE TIBIA. R. Stephens. *Journal A. M. A.*, March 31, 1923, p. 905.

The condition "is one of rather extreme rarity." The author has seen two cases in the last six years.

Case 1. A soldier, 19 years old, was tackled at football and brought to the ground. The knee showed extensive ecchymosis, heat, increased fluid, and almost complete limitation of motion. There was no marked lateral mobility. X-ray showed fracture of the upper end of the tibia in the knee joint, with a fragment including the entire spine of the tibia. The further history of this case is not available.

Case 2. Aged 16, was tackled at football and thrown to the ground For 4 months he was treated for sprained knee. There was no lateral mobility. He walked with a slight limp. X-ray showed fracture of the external tubercle of the spine with two small fragments detached.

The joint was opened by splitting the patella, and small bone fragments were found embedded in fibrous tissue. The mass of fibrous tissue which jammed between femur and tibia on attempted extension was excised.

Active movement was begun immediately, and walking was resumed on the 10th day. When seen later, function was normal and no discomfort of any kind was experienced. A short summary of the literature is given. The cause is always some severe traumatism that holds the leg and causes the body to twist violently, with the strain at the knee joint. The injury is frequently associated with rupture of crucial ligaments. Direct impingement of external margin of internal condyle on spine, or avulsion of the bony attachment of a crucial ligament probably causes the injury, as in analogous fractures about the ankle.

Treatment in early cases should be conservative. In late cases open operation for removal of the fragments is usually necessary. The final results are excellent in all cases.—*Alexander Gibson, F.R.C.S., Winnipeg.*

THE TREATMENT OF OLD, UNUNITED FRACTURES OF LONG BONES, WITH SPECIAL REFERENCE TO THE USE OF THE OSTEOPERIOSTEAL GRAFT. Henry Bascom Thomas, M.D. *Journal American Medical Association*, February 3, 1923.

Dr. Thomas in his paper brings out the necessity, as borne out by experience in the World War, of waiting for a year or more in compound ununited fractures before attempting repair by means of bone grafts. He lays special stress upon not disturbing the old ends of fragments because of uncovering sources of latent infection. He also recommends the use of a periosteal wafer graft composed of a layer of periosteum and a thin layer of bone in one piece as a means of supplying osteogenetic cells with a good blood supply, which is highly important in securing firm union.

The ordinary graft insert is cut a little wide, which insures a better fit. Over this is placed the wafer periosteal graft, which is sewed in place and holds the deep one, thus doing away with the necessity of pegs, screws, or sutures in the deeper insert.

The paper is illustrated by nine excellent cuts. Dr. Thomas also points out that the operation does not cease with cutting surgery and that the surgeon should also give his personal attention to the application of an appropriate splint, which he claims is no doubt the most important part of the entire procedure.—*H. A. Pingree, M.D., Portland, Maine.*

TREATMENT OF DUPUYTREN'S FRACTURE BY A SCREW THROUGH THE INTERNAL MALLEOLUS. G. Leclerc. *La Presse Médicale*, February 21, 1923, p. 165.

The author is convinced that the open and precise method in treatment of fractures is gaining ground, and that in a few years it will be the method of choice in all cases. There are too many poor and indifferent results by the closed method.

Fractures about the ankle especially need open operation. Disregarding the former classification by mechanism, most surgeons today think of these fractures as: (1) Fracture of one malleolus. (2) Fracture involving both malleoli. (3) Fracture of internal malleolus with fracture of lower end of fibula (Dupuytren type). (4) Internal malleolus and upper part of fibula (Maisonneuve type).

The usual treatment of the Dupuytren type has been to put up the foot in plaster in forced adduction. But the tibiotarsal mortice is not restored precisely by this method, and exact restitution is demanded in a joint of such importance. The Delbet walking plaster splint has been advocated for this fracture but it is illogical, because the fracture lies below the inferior point of support. The Championnière mobilization method is also illogical in this region because it ignores anatomical reduction.

The external malleolus is of lesser importance because the fibula takes no part in weight bearing, but the inner malleolus must be restored to its anatomical position and held there. This will bring the astragalus into proper relation

and indirectly through the malleolar ligaments will also put the external malleolus in good, though perhaps not anatomical, position.

The author uses a long screw to hold the internal malleolus in place. He has practised this method since before the war and has been able to note excellent late results. Juvara accomplishes the same result by nailing.

The operation can be done with local anaesthetic. The tibiotarsal joint as well as the fracture line and surrounding skin is well infiltrated with the liquid anesthetic and incision is made curved with convexity downward under the internal malleolus. The flap is turned upward and longitudinal incision then made along the malleolus up to the line of fracture. The periosteum is separated and the soft parts retracted out of the way. Having obtained reduction by lion-tooth forceps or otherwise, a 6 cm. screw is inserted through the malleolus and sunk into the tibia pointing upward and somewhat inward. The leg is placed in a wire splint and motion is begun in three or four days. The patient begins to walk in about a month.—*William Arthur Clark, M.D., Pasadena, Calif.*

OSTEOMYELITIS

OSTEOMYELITIS OF THE ILIUM IN CHILDREN. Carl Bearse. *Journal A. M. A.*, April 7, 1923, p. 991.

Infection of the ilium, far from rare, is most serious in children because of the difficulty of diagnosis. This condition should always be borne in mind in cases of painful hip that permit motion. Of the bones of the pelvic girdle the ilium is most frequently infected.

Two case reports are given:

1. Boy aged nine. Previous attacks of osteomyelitis, swelling of right hip, with fever and prostration. At operation a hole was found in the ilium near the crest.

2. Boy aged 13. Injury while playing football. High temperature, haematuria, sensitive right hip. At operation 4 ounces of pus were found and a bare area on the ilium with a perforation in the centre. Culture showed staphylococcus aureus.

Complications are frequent, such as dislocation of the hip joint, metastasis, amyloid liver, erosion of the femoral artery.

The treatment is early operation with adequate drainage and removal of dead bone, even if it means resecting the whole ilium. *Alexander Gibson, F.R C.S., Winnipeg.*

ACUTE OSTEOMYELITIS. Frank LeMoyne Hupp. *N. Y. Med Jour. and Med Rec.*, October 18, 1922.

Osteomyelitis is in a class by itself, a disease wholly surgical, and the medi

cal men must know the symptoms, recognize them without delay, and join hands with the surgeon for immediate and correct operative relief. There is scarcely any other well known and frequently seen disease in our hospitals today with respect to which there have been so many sins of omission and commission. Within a few hours of the onset of the acute symptoms of a virulent osteomyelitis, "the induction of pyogenesis in the medullary canal is followed by an enormous osteoblastic proliferation in the bone tissues, which is rapidly extended onto the surface, filling the areolar meshes, where the osteoblasts form osseous plaques and become adherent to the periosteum." The infection spreads with great rapidity beneath the periosteum, dissecting loose this fibrous membrane, and only limited at either extremity by the epiphyseal plates. There are many points in common in the early symptoms of rheumatism and osteomyelitis. The pain is severe and acute in both, the tenderness marked, and the white cell count increased with hyperpyrexia. In rheumatism frequently more than one joint is involved, unless the infection is Neisserian. In osteomyelitis rarely more than one locality is invaded, and a white cell count may run from twenty-five to forty thousand. There is greater intensity of the local symptoms, with involvement of the shaft or epiphysis, rather than the joints, and the constitutional disturbances are more profound. Very early there appears a slight edema and redness over the affected shaft, temperature often 104° to 105°, delirium, and profound exhaustion. The wise clinician will not wait for abscess formation and fluctuation, with this perfectly clear picture, but will give his patient that same prompt and wise counsel which he would an acute appendicitis. As the pathology advances, the pus of an osteomyelitis may perforate into a joint and confuse the picture with a septic arthritis, but the true lesion should be recognized before this disaster has occurred. How often has one seen a delay in the recognition of the pathologic condition until the pus has reached the surface of the bone, and the timid operator has satisfied his conscience with an incision of the abscess. He thinks he has done his duty, while the smouldering destructive volcano within the medullary cavity invites his trephine, chisel, and mallet. The medullary spaces everywhere communicate, so that a liberal opening through the cortex of the bone into the infected cylinder provides ample drainage in the acute stage of the disease. The bone curette must not be used in the medullary canal, for to traumatize the endosteum would be as irrational as to scrape the membranes and vascular lining of a phlegmon elsewhere in the body, and may lead to a destruction and necrosis in the bony canal.—*Walter G. Elmer, Philadelphia.*

ACUTE OSTEOMYELITIS IN CHILDREN: REPORT OF CASES. J. C. Willis, Sr., and J. C. Willis, Jr. *New Orleans Med. and Surg. Journ.*, January, 1923.

Four cases are reported and the disease is described very carefully as to its etiology, course, and differential diagnosis. The authors make a plea that the disease be treated wholly surgically: the earlier the operation the better the outlook for life and limb. The medullary cavity should be given prompt and efficient drainage.—*Edward S. Hatch, M.D., New Orleans, La.*

POSTURAL AND STATIC DISTURBANCES.

Modified Operation for Hallux Valgus. S. Keszly. *Zentralblatt f. Chir.*, Jan. 20, 1923.

The operation consists of five phases:

1. Four to five cm. long incision on the median surface of the metatarsophalangeal joint of the big toe. Removal of bursal sac.

2. Chiseling off of the exostosis and smoothing of the bone wound.

3. Wedge shaped resection of the head of the metatarsal. The wedge has its base on the inner border, its apex on the outer border of the foot, and reaches the neck of the metatarsal. The direction of the wedge and its size are of importance and depend upon the degree of toe deviation. The purpose is to bring the articulating surface in line with the long axis of the metatarsal shaft and the toe in the direction of Meyer's line. It is essential that the wedge be removed as near the metatarsal head as possible and that the head should not be chiseled through entirely, but only to the cortical layer of the external surface, thus leaving it and its periosteal covering untouched. The remaining joint end is pressed against the stump of the metatarsal shaft and the toe thus brought in the desired direction. Closure of joint capsule.

4. Tendon transplantation. The tendon of the musc. extens. hallucis longus is split in two and an inner arm is attached to the base of the last phalanx. This tendon plastic is for the purpose of retaining the toe in the corrected position.

5. Closure of the incision.—*A. Gottlieb, M.D., Los Angeles.*

Orthostatic Albuminuria. Wilbur E. Post, M.D., and William A. Thomas, M.D. *Journal American Medical Association*, February 3, 1923.

The authors have given a rather exhaustive consideration of the subject and have quoted extensively from the investigation of others. It does not appear that lordosis, the horizontal position, or the upright position of the body are important factors in the production or control of albuminuria. Their summary and conclusions follow:

SUMMARY.

Observations covering approximately forty cases of orthostatic albuminuria indicate that the appearance of variable amounts of nucleo-albumin and serum-albumin in the urine in such cases is analogous to changes taking place in the blood and body tissues.

The condition, which appears most frequently in the young, in certain types of individuals, particularly the undernourished, rapidly-growing ones, with unstable venous and vasomotor mechanisms, and frequent or chronic infections, is accompanied by a pulse pressure smaller in the upright than in the lying position, is aggravated by immobility, and presages no progressive renal disease.

Repeated and accurate functional tests and blood chemistry observations reveal neither constant deviations from the normal nor constant variations between the upright and horizontal positions.

CONCLUSIONS.

1. Neutralization or mild alkalization of the urine produces changes in the kidney, blood, or body tissues which are followed by disappearance of nucleo-albumin and serum albumin from the urine, by restoring to normal the physico-chemical state of the proteins and preventing their escape into the urine.

2. Neutralization may be brought about by administration of various alkaline salts, such as sodium or potassium acetate, or sodium citrate or calcium lactate, and similarly by the vegetables and fruits in the diet that contain alkalizing salts.

3. Other factors influencing this form of albumin in the urine are: circulatory efficiency in the kidney itself or in the body itself, and metabolic efficiency in the blood and body tissues as influenced by other factors than circulation, such as the conditions producing rapid growth in youth, and by infections and intoxications.—*H. A. Pingree, M.D., Portland, Maine.*

IS ORTHOSTATIC ALBUMINURIA A UNILATERAL DISORDER? Clarence Quinan. *Journal A. M. A.*, March 31, 1923, p. 899.

Pavy first described in 1885 a condition in which albuminuria is present while the patient is up and about, but disappears after rest in bed. In this paper are detailed the results of some kidney fixation experiments in a marked case of orthostatic albuminuria. These experiments cover a period of eight years.

Germane to the subject are:

1. *Palpatory albuminuria.* The fact seems to be established that manipulation of the renal cortex causes albumin to appear in the urine.

2. *Movable kidney and lordosis.* On the theory that orthostatic albuminuria connotes a venous stasis due to compression of the renal veins, it is held that renal mobility and lordosis facilitate obstruction. Even in the horizontal decubitus it is believed albuminuria can be induced by lying on a hard pillow.

3. *Clinostatic albuminuria.* "In some patients with considerable splenic enlargement, rest in bed or in the recumbent position may be accompanied by albuminuria, and the albumin may disappear from the urine when the patient assumes the erect position."

4. *Ureteral catheterization.* In a case recorded by Vorpahl the albumin came from the right kidney alone. Sonne, on the other hand, advanced the idea that orthostatic albuminuria was always left sided, and was due to compression of the left renal vein by the lordotic vertebral column, the pressure probably being transmitted through the abdominal aorta.

Case report. A man aged 30, erect, muscular, free from lordosis, has had for at least eight years a clino-orthostatic albuminuria. The right kidney was freely movable. A kidney clamp was devised to provide fixation of one kidney at a time. Forty experiments were made and 120 samples of urine were tested by Esbach's method. Experimentally, the orthostatic albuminuria was not

affected by the supporting of either kidney alone, or both kidneys together. On the other hand, the clinostatic albuminuria could be greatly reduced by having him sleep with the foot of the bed raised a few inches.

The writer's conclusion is that no support is lent to Sonne's theory that orthostatic albuminuria is always left-sided.

Ureteral catheterization was never carried out. The suggestion is made that a purely mechanical origin for the malady is inadmissable. Probably several factors are concerned, and one of these in all probability will have to be sought for in the autonomic nervous system.—*Alexander Gibson, F.R.C.S., Winnipeg.*

A NOTE ON THE QUESTION OF THE CAUSATION OF POSTURAL OR ORTHOSTATIC ALBUMINURIA. F. Parker Weber. *British Jour. Children's Diseases,* April-June, 1922.

True orthostatic albuminuria is often connected with the tall, "lanky" build of body suggestive of visceroptosis, in which there is often some degree of lordosis likewise present. In cases of orthostatic albuminuria, temporary albuminuria can sometimes be produced by artificial lordosis, even when the patient remains lying in bed. The suggested explanation is that the albumin comes from the left kidney, only due to lordotic pressure on the left renal vein, which has to pass in front of the vertebral column and the aorta. This is confirmed by catheretizing the ureters. Both granular and hyaline tube casts can often be detected in the albuminous urine from cases of orthostatic albuminuria. Lordosis cannot be the only factor in the cause. There must also be an individual predisposition. It is often in the morning that the albuminuria is most marked. It occurs chiefly, but not always, in early life, up to 25 or 30 years of age. Lordosis does not always produce orthostatic albuminuria. Enlarged spleen and hepatic cirrhosis may be a factor. Hematuria may be present when marked lordosis mechanically disturbs the circulation of the left kidney. In uncomplicated cases of orthostatic albuminuria the life may be regarded as a normal one from the life assurance point of view.—*Walter G. Elmer, M.D., Philadelphia.*

AN OPERATION FOR HALLUX VALGUS. Percy W. Roberts. *Jour. A. M. A.,* Feb. 24, 1923, p. 540.

The author presents a new and interesting operation for hallux valgus deformity. He reaches the operative field through an elliptic incision which permits the removal of the redundant skin and bursa in one mass. The tendon of the extensor hallucis is cut a short distance above its insertion; the tendon and its sheath is dissected free to a point above the head of the first metatarsal. The tendon is then implanted in a shallow canal on the medial side of the base of the first phalanx, covered with periosteum, and sutured into position. A wedge is excised from the base of the first phalanx, and its articular surface is concaved. A wire splint is used between the first and second toes in the dressing. The article is well illustrated.—*Edward S. Hatch, M.D., New Orleans, La.*

FOOT STRAIN IN GOLF. N. D. Mattison. *N. Y. Med. Jour. and Med. Record*, Feb. 7, 1923.

As stated by the author, this article is intended to direct attention to the feet as a factor in control and maintenance of body balance and to the causes and results of foot strain due to habitually faulty use of the feet, particularly in the playing of golf.

This is a lengthy and intricate discussion of the physics and mechanics of weight bearing and movements as they affect the feet of the golfer. It is claimed that the game makes exacting demands on the feet, chiefly because the player does not usually keep his feet parallel during the strokes.

While this attitude of the feet is generally conceded to be the strong position for ordinary standing and walking it does not necessarily follow that it is best for either one's feet or one's game to maintain this parallel position while making a stroke at golf. The author fails to note that in the usual "stance" (with toes pointing more or less laterally) the legs and thighs are correspondingly everted with knees slightly flexed and facing in the same direction as the feet. This means that this does not necessarily involve or encourage pronation of the foot in relation to leg, even while addressing the ball, but is the natural position which gives greater stability and freedom during the rotary movement of the body in making the stroke. One cannot make a full, free swing of a golf club with both feet held parallel and firmly implanted throughout the stroke. Rotation to the right would be checked or undue strain be thrown upon the right knee and ankle before the "top of the swing" could be reached. It will be noted that during the back stroke and first half of the forward stroke (until the club strikes the ball) most of the body weight is on the right foot, and that during this period the body and right thigh and leg are rotated to the right in relation to the foot, i. e., the foot is more or less inverted and adducted on the leg during this period, even in the usual stance. The left foot is likewise protected during the finish of the stroke when it has to bear most of the body weight.

The author seems to have overlooked some important factors in his study of golf strokes.—*R. W. Billington, M.D., Nashville.*

MISCELLANEOUS

CONTRACTED ACHILLES TENDON. A. Gottlieb. *N. Y. Med. Jour. and Med. Record*, Feb. 7, 1923.

The conditions generally included by this are, in fact, usually contractures of the calf muscles rather than of the Achilles tendon. It may be congenital or acquired, 96 per cent being of the latter. Causes of acquired types include: trauma to leg, ankle, and foot, prolonged faulty position in bedridden patients, constitutional diseases, such as gout and chronic arthritis, spastic and flaccid paralysis, especially poliomyelitis, local acute and chronic inflammation of ankle joint and calf muscles, and habitual wearing of high heeled shoes.

Some of the usual preventive and corrective methods of treatment are briefly discussed.—*R. W. Billington, M.D., Nashville.*

OSTEITIS OF THE ILIAC BONE. Aug. Broca. *Paris Médicale*, February 24, 1923.

Some interesting roentgenograms of extensive osteomyelitis of the pelvic bones are shown, and five cases are reported.

Case 1. Girl of 12. Cold abscess draining on the posterior lateral aspect of the thigh for the past six weeks. Has had trouble, however, for the past five years. This seemed to be a tubercular abscess, in spite of the positive Wasserman. A sequestrum was extracted in May, 1912. The sacro-iliac joint was involved and became ankylosed, and the affected half of the pelvis became distorted and pushed upward. The picture shows the upper half of the ilium denuded, rough, and irregular. The girl was sent to Berck in July, 1913, the sinus having closed without another operation. Mixed treatment had no effect on the bone condition.

Case 2. Child of 6. Large abscess over left ilium from which five sequestra were removed. A persistent fistula required another operation, and after about five years the patient recovered. Roentgenogram showed upper posterior two thirds of ilium honeycombed and edges serrated.

Osteitis in this region of the pelvis does not involve the hip, but in the pubic and ischial bones the disease may involve the joint also.

Case 3. A boy of nine; died from an extensive necrosis of the pubis and ischium which invaded the hip after three years duration.

Case 4. A boy of eight, had the same condition in the pubic bone where it was possible to remove the sequestrum without disturbing the joint. He recovered.

Case 5. A boy of five who had an abscess in the pubic bone. A sequestrum was removed about eighteen months after onset of the disease. Not seen since then.—*William Arthur Clark, M.D., Pasadena, Calif.*

OSTEO-ARTICULAR SYPHILIS. Paul Gaston. *Paris Médicale*, March 3, 1923, p. 200.

Diagnosis of syphilitic lesion of the bones and joints has always been rather difficult because of confusion with tuberculosis, chronic rheumatism, infectious arthritis, gonorrheal arthritis, and arthropathies of nervous origin. In addition, the luetic affection may be masked by trauma or acute infection.

Fouquet and Benazet classify the acquired lesions as follows:

Secondary arthropathies, including subacute synovitis, chronic synovitis and hydrarthrosis; tertiary, including osteo-chondro-arthropathy, syphilitic white swelling, gummatous peri-synovitis.

Fournier estimated that 39% of the cases were hereditary and von Huppel states that the percentage is 56.

The following varieties are described by Fournier: 1. Arthralgic form with rheumatoid pains. 2. Hydrarthrosis. 3. Osteo-arthritic form of slow development with pain and formation of hard masses simulating foreign bodies. 4. White tumor, a globular shaped swelling of a joint without loss of function. 5. Arthropathy with involvement of ephiphysis, osteophytic vegetations, muscu-

lar atrophy, and limited motion. 6. Rheumatic deformity type localized in the large joints. To these may be added the arthropathies from tabes and other nervous affection of luetic origin.

Five cases are reported by the author.

Case 1. Man of 20. Pain, swelling, and loss of function in both knees and in fingers of one hand coming on three months after primary chancre. Roentgenogram negative. Temperature 37.8 to 38.4. Positive Wasserman. Joint condition cleared up under mercury.

Case 2. A man of 60 had had a primary lesion at 18. Troubled for several years lately with swelling and pain in the left knee. Tenderness and more or less disturbance of function. Wasserman positive. Finally in 1921 came a crisis with complete loss of function in the joint. In 1922 another crisis with intense pain over the patella, keeping him in bed. Skin red and tender, giving an appearance of suppuration. Roentgenogram showed erasion of the patella, points of rarefaction in upper end of tibia, roughening of the articular surface, and irregular proliferation of the periosteum. This man was cured by anti syphilitic treatment so that he was able to return to work.

Case 3. A woman with pain, swelling, and disability of left knee. Her husband died of a mediastinal growth which was not correctly diagnosed but which on later consideration and in view of a positive Wasserman in the woman was regarded as luetic. The knee swelling was globular in contour and tender on the sides. Flexion almost impossible and very painful. Roentgenogram showed proliferative lesions of the tibia and femur near the joint, irregular articular surface and nothing around the joint. A diagnosis of joint syphilis was deemed justifiable because of the positive serologic tests and the family history. Treatment was not effective, but, however, not very intensive.

Case 4. Woman of 60 with painful swelling of both knees which showed osteophytic proliferation and periarticular mottling. She and her husband had positive Wasserman tests.

Case 5. Woman whose father had died with tabes, began to have pain in the knees at 30. At 40 she had also pain and swellings in fingers of both hands. She had inequality of pupils, Argyll-Robertson reaction, frequent incontinence of urine and absent knee-jerks. Bordet-Wasserman reaction negative but Hecht positive. This case is considered a late manifestation of hereditary syphilis.

The acquired form of luetic osteoarthritis is characterized (1) by swelling, usually without redness or fluctuation, except in case of hydrarthrosis; (2) by pain, either spontaneous or on movement, and tenderness on pressure; (3) by impairment or loss of function. The lesion is frequently bilateral and sometimes multiple.

Roentgenographic findings are of three types: (1) proliferative, with periosteal thickening and osteophytes on the epiphyses or on the cartilages; (2) rarefying type, showing clear spaces which later become sclerotic; (3) destructive type, similar to tuberculosis. In severe cases the inter-articular line may be narrow and irregular and the destruction may be so great that loose bodies can be seen.

Clinically, a differential diagnosis must be made from chronic infectious arthritis, sarcoma, tuberculosis, and osteomyelitis

Arsenic preparations intravenously associated with bismuth, mercury, and iodides should be used in treatment. A bismuth preparation known as muthanol seems to be especially efficacious in these joint lesions.—*William Arthur Clark, M.D., Pasadena, Calif.*

THE ROLE OF SUNLIGHT IN PROPHYLAXIS AND TREATMENT OF RACHITIS. P. F. Armand-Delille. *La Presse Medicale*, February 17, 1923, p. 159.

Since the celebrated work of Glisson in 1659, rachitis has been the subject of innumerable studies. Among the numerous theories, the intestinal factor seems to hold first place now, and since the discovery of vitamins, it has been thought that a key to the problem is now available. Lately the work of Rollier, Hess, and others shows that sunlight plays an important part in nourishment and that its absence favors development of rachitis. Hess and his co-workers conclude after comprehensive studies that vitamins have only a secondary effect and that their absence does not predispose to rachitis. The idea that phosphorus and calcium are lacking in the diet of rachitic children is dismissed by the findings of Sherman and Pappenheimer that human or cow's milk contains more than enough of those elements to supply the bones.

In his studies, Hess was struck by the increase in number of rachitis cases in winter and spring and decrease in summer. Acting on this suggestion, he began to expose the rachitic patients to the direct sunlight. The results were very encouraging. Not only did the children gain in vigor and general nutrition, but the symptoms of rachitis rapidly disappeared. The epiphyseal tumefactions subsided in the parts not directly exposed to the sun rays, proving that heliotherapy has a general and not merely a local reaction. In a series of cases it was found that during sun treatment the phosphorus content of the blood was raised from 2.8% to 4.13% in one case, in three months treatment, 2.77% to 4% in another, and 3% to 4% in another case after four months. Experiments with white rats in which rachitis was produced by diet showed that the development of the rachitic symptoms was precluded by keeping the animals in direct sunlight.

Vallot, at Nice, was able to increase metabolism by heliotherapy. In some cases the assimilation of certain food substances was increased two and a half times. It was once thought that sea air was necessary in conjunction with heliotherapy but this idea has been refuted by the remarkable results obtained by Rollier in the mountains. Also it was observed by the author that a child of 2½ years was almost completely cured of rachitis by six weeks heliotherapy in Paris while awaiting admission to the hospital at Berck on the sea.—*William Arthur Clark, M.D., Pasadena, Calif.*

RESECTION OF THE KNEE BY MEANS OF A SAW WITH TWO PARALLEL ADJUSTABLE BLADES. J. Calvé and M. Galland. *La Presse Médicale*, March 7, 1923, p. 379.

Resections of the knee joint are not always followed by good results either

because solid union fails or because the union is obtained in a bad position. A frequent cause of failure to get an ankylosis is poor coaptation of the new surfaces. The surgeon may make a slight error in the angle of resection on one bone or the other; even if this is discovered the attempt to correct it usually leaves a rolling instead of a flat surface. Another difficulty is that although the leg is placed in proper alignment in a cast the resection surfaces may not be in apposition because of slight movement inside the cast. There may be a sinking backward or a slight lateral motion giving rise to valgus or a varus deformity.

To obviate these difficulties, Dr. Galland devised a double bladed saw with which to make both tibial and femoral cuts at the same time. The parallel blades of the saw are adjustable to the desired width of resection, and it is impossible to have one surface at an angle with the other when the saw cuts are made. It is not even necessary to make the cuts perpendicular to the long axis of the bone because the two surfaces being absolutely parallel, both laterally and antero-posteriorly, they will fit together. The knee is held at the angle at which consolidation is desired by placing a sand bag of proper thickness under it.

Nothing is said in this paper about the handling of the soft parts. It would seem that in order to make the perpendicular saw cuts clear through the bone with the knee extended a very extensive incision would be necessary.—*William Arthur Clark, M.D., Pasadena, Calif.*

OSTEOMALACIA WITH EPILEPSY. A. Brenner. *Deutsch. Ztschr. f. Chir.*, Nov., 1922.

The frequency of bone malacia in late years and the uncertainly of its etiology warrant the quoting of a case of osteomalacia with epilepsy which, briefly, is as follows:

Woman of 32. Parents healthy but died of "cancer" in advanced age. Grandmother, on mother's side, suffered from sudden attacks of convulsions with loss of consciousness. As an infant, patient was weak and slow in development; had cramps during dentition. As a child, physical and mental growth was retarded; she had the common diseases of childhood. At age of 14 began to earn a living and to perform, at times, pretty strenuous physical labor without any untoward effects. Menstruation began at 14 and was regular and painless.

At age of 25, without previous warning, had epileptic attack with loss of consciousness. Repetition of attacks about every 4 to 6 weeks occurring in the day time and in later years predominantly at night during sleep. Received bromide medication which she did not tolerate and which did not influence the attacks.

When 27 years of age gave birth to child, healthy and strong girl, whom she nursed. Pregnancy and parturition were normal.

Two years later, during the second pregnancy, patient complained of fatigue, difficulty in walking, and a painful, gradually increasing weakness in the legs. She gave birth to a puny boy, who, although breast fed, grew slowly in body

and functions, and developed, at the age of 3, progressive deformities of the legs. During both pregnancies the epileptic attacks were rare; after the second parturition they occurred more frequently and in severer form. During this period, the war time, she and the children suffered great want, lack of food and fuel. About this time, at the age of 29, pain in the region of the pelvis and in the legs made its appearance. The pain was so severe and accompanied with so intense tenderness on the slightest pressure over the lower back, the pelvis, and the legs, that standing or walking became impossible.

Following a particularly long and severe attack, patient was entirely unable to move the left leg, which was extremely painful and rotated outward. She sustained a spontaneous fracture of the neck of the femur. The femoral head was removed and the wound healed in a short time.

At this time the patient noticed that she grew shorter; the spinal column began to bend, the trunk of the body sank, as it were, between the thighs. She became emaciated, pale, lost weight and strength, suffered insomnia, and the epileptic attacks became more frequent. No difficulty in micturition and defecation.

At this time the patient presented herself for treatment of her deformity. The clinical findings were: Highly emaciated woman with a peculiarly sunken and shrunken body; extreme paleness of skin and mucous membrane; no edema, exanthema or glandular enlargements; general musculature markedly feeble and hypotonic; tenderness over the skull, particularly over the frontal tuberosities; no asymmetry of skull; pupils equal, reacting to light and accommodation. No definite abnormalities in oral and nasal cavity; slight enlargement of thyroid. Marked right-sided kyphoscoliosis of the dorsal and lumbar spine. Definite rachitic rosary. Flattened chest which has sunken down and rests on the pelvis. Excessive tenderness on pressure of the entire pelvic ring. The pelvis with its beaklike prominence of the symphysis makes the peculiar impression of having been squeezed together sideways. Marked tenderness of the spine, the sternum, ribs, arms, and knees, which present a genu valgum position, due especially to curving of the femora. Right sided coxa vara with interference of abduction of the thigh; left leg, operated upon and shortened, is in position of inward rotation, adduction, and flexion. Extreme spasm of the adductor muscles of both thighs. Gait is waddling and stiff-legged, taking only very small steps. The epiphyses of all long bones are enlarged. Lungs, heart, and abdominal organs seem normal. Tendon reflexes are exaggerated. Chvostek signs positive. Trousseau negative. Increase of galvanic irritability of motor nerves of extremities. Mental depression and lack of memory. Urine neg. Blood, hglb. 75%, 4 mill. reds; 6900 poly. 50% large and 5% small lympho. 38% mono. 2% eos.

Radiograph: markedly heart-shaped, atrophic, and several times fractured pelvis. The kyphoscoliotic vertebral column sunken into the pelvis so that the transverse processes of the fifth lumbar touch the ilia. Callus formation in the region of the resected left femoral head. Rarefication of the long bones, especially the femora. No changes in the skull bones.

The clinical examination of the children reveals: Girl, 5 years, pronounced rachitic bone changes. Boy, 3, severe rachitis with signs of spasmophilia.

The question presents itself: Shall this case be regarded as a malacia of bone from underfeeding or be considered as a puerperal osteomalacia?

The clinical picture corresponds undoubtedly to the puerperal form, but the course of the disease and, particularly, the existence of tenderness of the skull are characteristic of hunger-malacia. It may be assumed, therefore, that both factors served as causes in the production of this picture.

Significant in this case also is the relation between rickets and osteo-malacia. In the adult, the developed bones of the mother, osteomalacia made its appearance; in the young, the children, rickets developed. In both diseases a derangement of calcium metabolism is obvious, while the clinical pictures vary only in intensity of bone involvement.

The occurrence of epilepsy with osteomalacia, this being the only case reported in recent literature, can be explained only on the basis of a disturbance of endocrine balance, namely, inefficiency of parathyroid secretion which, according to Curschman and Bauer, may result in spasmophilia and tetany during childhood and in epileptiform attacks in later life. Conditional disturbances of the endocrine apparatus in individuals predisposed to epilepsy may give rise to the epileptiform symptomcomplex (Bauer), the conditions here being pregnancy and starvation.

In this patient the hereditary predisposition, a weak skeletal system, spasmophilia, and rickets existed in childhood; at 28 epilepsy broke out, to which were added, four years later, starvation and pregnancy, which acted to complete the picture: osteomalacia with epilepsy.

The treatment was outlined according to Curschman's observations that epilepsy which follows spasmophilia of childhood does not respond to bromide administration. The treatment of epilepsy was disregarded and the entire attention was given to the malacia. Phosphorus was administered in the form of phosphor-cod-liver-oil, which was tolerated in large doses (total phosphorus per day 0.05 G.) and acted like a specific. Besides that, calcium preparations in doses up to 1.0 G. were given daily. Adrenalin injections were tried, but had to be discontinued because of utter intolerance.

The improvement was rapid and effective in every respect; the adductor spasm of the legs disappeared, the intense pain gradually left, all body functions became normal, and the attacks occurred very seldom, were mild and of short duration. Even the x-rays showed changes in bone structure and callus formation of the fractured bones.—*A. Gottlieb, M.D., Los Angeles, Calif.*

TUBERCULOSIS OF ANKLE JOINT AND TARSUS. Henry J. FitzSimmons. *Boston Med. and Surg. Jour.*, Dec. 7, 1922.

The author quotes the figures of Dr. J. W. Sever as given in a paper covering the period from 1868 to 1910, and compares these with the cases treated in the hospital during the last ten years. These latter cases he divides in two groups those which had been treated conservatively and those which had been operated upon one or more times. The results obtained and the length of time the cases were under treatment are given in detail. In the groups of conservatively treated cases, twenty-five of which are recorded, there developed three cases of tuberculosis of the spine, one case of general tuberculosis, and one case of

tuberculous meningitis. The author reaches the conclusion that the operative treatment of the ankle and tarsus in children is harmful, time is not saved, deformity is not decreased, and motion is not preserved. The cases in the operative group that were followed by the quickest healing and usually by the best surgical results were those that had been submitted to small incisions of the fluctuating mass of an abscess about to spontaneously rupture. Local rest by fixation, protecting against the strain and mechanical pressures to which the individual bones or joints are subjected, should be rigidly enforced. Heliotherapy aids before as well as in the presence of sinuses. A large proportion of cases of tuberculosis of the ankle joint and tarsus get good functional results with very little deformity, but are more likely to get these results in a shorter time by the non-operative procedure.—*Walter G. Elmer, M.D., Philadelphia.*

OSTEOPSATHYROSIS: REPORT OF A CASE WITH ROENTGENOGRAMS OF ELEVEN DIFFERENT FRACTURES IN THE SAME PATIENT. Donald M. Glover. *Archives of Surgery*, November, 1922, p. 464.

This series of roentgenograms gives a graphic fracture history of the patient from the time he was nine months old until his death at 7½ years. Over 200 cases of this condition have been collected by various authors. It is also called fragilitas ossium, and osteogenesis imperfecta.

This case is reported in detail with excellent roentgenograms showing the various fractures. The classification of cases, etiology, pathology, sympatomatology, prognosis, diagnosis, and treatment are discussed. Numerous references to the literature of the subject are given.—*F. G. Hodgson, M.D., Atlanta, Ga.*

REEDUCATION IN WRITERS' CRAMP. P. Kouindjy. *N. Y. Med. Jour. and Med. Rec.*, Nov. 15, 1922.

Occupation cramps are characterized by spastic contraction occurring at the start or in the course of the execution of regular and sustained work. Occupational spasm may occur without being accompanied by the least degree of painful and involuntary contraction of any of the involved muscles. Writers' cramp is the commonest form of occupational cramp and the most extensively studied. Duchenne described three forms: 1, the spastic form, characterized by muscular contraction, either painful or painless; 2, the tremulous form, characterized by clonic or tremulous contraction; and 3, the paralytic form, presenting paresis or even paralysis of one or several muscles. Local conditions such as tenonitis, local neuritis, arthritis, periostitis, myositis, etc., may be a factor in the cause of the disease. They may cause a psychoneurosis which at times attains such a degree that the disturbance exhibits all the earmarks of an affection of central origin. The individual psychic factor of the patient plays an important rôle in writers' cramp. The disease may be called an occupation ataxic neurosis. Many remedies have been tried and have been unsuccessful. The only rational

treatment consists of systematic massage and reeducation, supplemented by hydrotherapy. In the majority of instances of writers' cramp the spasm is located in one or more flexor muscles or in the adductors. These muscles are then in a condition of hypertonicity, while their antagonists, the extensors and abductors, are in a condition of hypotonicity. These latter must be subjected to massage, superficial and deep effleurage, followed by circular and deep pressure, to which are promptly added percussion with the finger or hammer, tappings and vibration treatment. This is supplemented by active exercises for these same muscles. These are described in detail. The patient is then taught to write with the hand inverted, very slowly and deliberately making the strokes, with rest periods in between. These exercises in reeducation are also carried out by the patients at home in the form of set tasks not exceeding twenty to thirty minutes a day. When he has thus learned to write with his extensor muscles, the hand being inverted, he is allowed to write in the ordinary way from time to time on condition that he does so deliberately and slowly. The patient thus acquires the ability to employ regularly two forms of writing. The duration of the treatment is from two to four months, and observation of the patient once or twice a month for several months longer. A treatment at such resorts as Aix-les-Bains or Royat, with local and general douches, may be serviceable in supplementing the treatment.—*Walter G. Elmer, M.D., Philadelphia.*

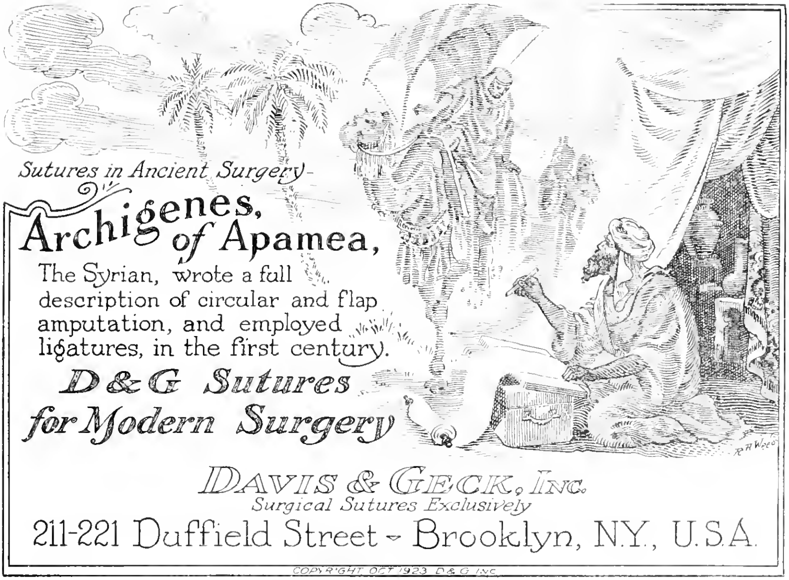
THE SURGICAL RECONSTRUCTION OF PARALYTIC UPPER EXTREMITY. Arthur Steindler. *Illinois Medical Journal*, March, 1923.

In the treatment of paralytic conditions of the upper extremity Steindler states that we have the following single problems to deal with: the flail shoulder, the flail elbow, the drop wrist, and the flat hand, and outlines his procedures for the care of each condition. For the flail shoulder he advises arthrodesis with the arm in 90 degrees of abduction and slight forward flexion in children, preferably 12 years old or older, and in 70 degrees of abduction in adults.

Inability of elbow flexion is treated by transposition of the flexor group of forearm muscles from their normal attachment to a position two inches higher up on the humerus to increase the slight normal flexor action of these muscles. A pre-requisite to success is some flexor function in the transplanted muscles. For the wrist drop, arthrodesis of the wrist joint has been given the preference in most cases.

The lack of function of the opponens pollicis is overcome by carrying one half of the tendon of the long flexor of the thumb around the metacarpal and fastening it dorsally to the base of the basal phalanx of the thumb. He reports on 40 cases of arthrodesis of the shoulder, 30 flexor plasties of the elbow, 10 arthrodeses of the wrist, and 15 flexor plasties of the thumb. The percentage of successes was large.

(A visit to the Steindler clinic abundantly confirms the striking results he has obtained in his reconstruction surgery of the upper extremity.)—*C. A. Parker, M.D., Chicago.*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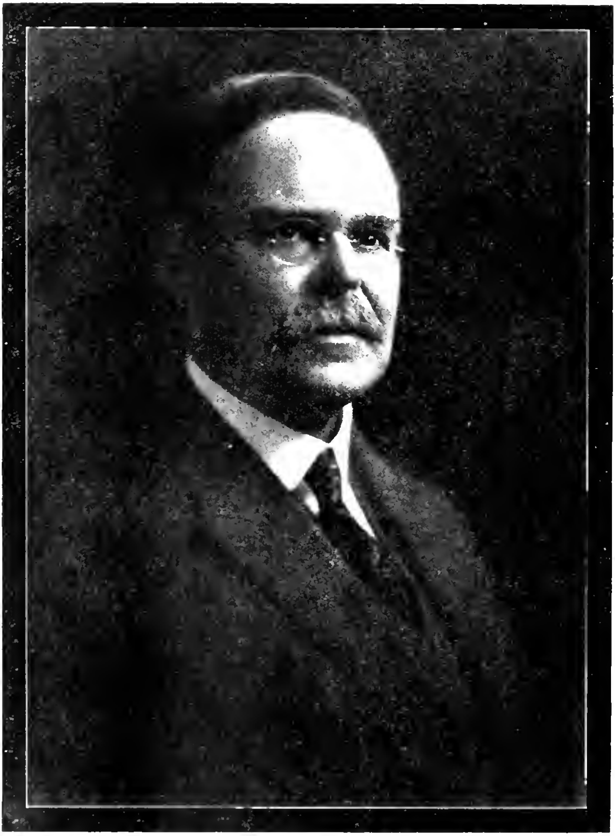

Henry Ling Taylor, M.D.
1856-1923

Vol. V, No. 4 OCTOBER, 1923 Old Series Vol. XXI, No. 4

The Journal of Bone & Joint Surgery

HENRY LING TAYLOR, M. D.

Henry Ling Taylor, one of New York's foremost orthopaedic surgeons, died at his home in Montclair, N. J., June 9, 1923, after an illness of several months' duration. Dr. Taylor's death closed a career which was characterized by unswerving devotion to the highest ideals in both his personal and professional life and he will be remembered as a man of simple tastes, content to labor in his chosen field without thought of self-aggrandizement, seeking only the interests of those whom he was called upon to serve.

He was particularly interested in the younger generation of the profession, and many men who have gained prominence in their specialty owe their opportunity to prove their worth to Dr. Taylor's influence and wise counsel.

Born March 17, 1856, in New York, Henry Ling Taylor was educated in private schools of his native city and Hanover, Germany, and graduated with high honors from Yale, Class of '77. He prepared for his medical work at the College of Physicians and Surgeons, New York, graduating in 1881 at the head of his class. After studying in the best clinics abroad he settled in New York to assist his father, Dr. Charles Fayette Taylor, one of the pioneers of orthopaedic surgery. He was for many years professor of orthopaedic surgery at the New York Post-Graduate Hospital and School, attending surgeon to the Hospital for Ruptured and Crippled, consulting orthopaedic surgeon to Mountainside Hospital, Montclair, N. J., a Fellow of the American College of Surgeons, past president and member of the

American Orthopedic Association, member of the New York Academy of Medicine, the American Medical Association, the New York County Medical Society, the Northwestern Medical Society, one of the founders of the American Posture League, of which he was secretary, and one of the founders of the New York Physical Education Society. He contributed generously to the literature on orthopaedic surgery and was the author of a standard textbook on the subject.

In 1890 Dr. Taylor married Margaret Brodt of Dansville, N. Y., who survives him, as do their four sons.

In the passing of Henry Ling Taylor the medical profession loses one of its finest characters, whose exemplary life cannot fail to leave an enduring impression on those who were fortunate enough to know him intimately.

P. W. R.

INTERNAL DERANGEMENTS OF THE KNEE.

A Review of the Subject With a Report Based on 181 Operated Cases.

From the Orthopaedic Clinic of the Massachusetts General Hospital, Boston, Mass.

BY J. K. SURLS, M.D., AND R. B. OSGOOD, M.D., BOSTON.

FOREWORD

Since Dr. E. A. Codman has stimulated end result study, more of these helpful analyses have been attempted and a clearer evaluation of methods of treatment has been gained thereby. Many of these end result studies have seemed to us to lack conclusiveness for several reasons:

1. They do not cover a sufficient period of time.
2. They have not included a sufficient number of cases.
3. The "follow-up" has not been prosecuted with sufficient energy to secure a high percentage of end results of the given series.
4. The analyses have not been made under a sufficient number of headings to make possible a fair interpretation of the findings.

In short, the studies have often seemed to lack a thoroughness of search and have been inconclusive as to the true meaning of the results. The ability to draw rational conclusions which may guide future treatment, alone can justify the considerable labor and expense which any extensive end result study entails.

It was with the purpose of ascertaining how complete an end result study could be made without padding or unprofitable detail that the present one was undertaken. If it should be found fairly complete and inclusive, the credit for it must be given to Dr. Surls, who in the busy life of an interne has found time to follow up and record a large percentage of the cases seen in a floating hospital clinic. His is also the careful analysis of the findings from the point of view of both patient and surgeon. All the laborious part of the work he has performed.

Robert B. Osgood, M. D.

CONTENTS.

INTRODUCTION.

THE writers desire to lay stress on the fact that this paper is, in great part, a *review* of the subject and did not involve original work. They have listed their involuntary co-authors in the bibliography. They have not hesitated to borrow plumage from all available sources. The lineage of the hybrid creature so produced can easily be traced to clinic and laboratory both in this country and abroad.

References to other writers have been made as complete as possible. Their articles, listed in the bibliography, give important details of subjects necessarily summarized in our paper.

DEFINITION.

An internal derangement of the knee is a mechanical derangement, caused by a product of the joint itself and lying within the joint. The obstructing tissue may be the result of either a sudden or a slow process —an injury or a gradual degeneration of the tissues, or both combined. A foreign body, such as a needle, may, of course, cause an internal derangement; but such cases are excluded by the above definition, in accordance with the general understanding of the term.

HISTORY.

Famous names are associated with one of the types of internal derangement—loose bodies. The condition is evident but the cause, obscure. The problem is therefore the sort to appeal to the active-minded surgeon seeking for ultimate causes.

Paré was the first to refer to loose bodies in the joints. In 1558 he successfully removed a loose body from the knee. In his writings, he included loose bodies under the heading of "Monstrosities." Alexander Monroe, in 1758, was the first to recognize that loose bodies might be derived from the articular ends of bones. John Hunter, one year later, recognized the occurrence of loose bodies from hypertrophic outgrowths in a knee which he had dissected. He investigated the subject of loose bodies during the last years of his life, and his observations were published by his brother-in-law in 1793, the year of Hunter's death.

These observations of Hunter were incorrect because of the erroneous pathology upon which he built them, and not because of illogical reasoning. He believed that extravasated blood, upon being organized, assumed the nature of whatever tissue lay adjacent to it, and explained the occurrence of cartilaginous bodies in the knee-joint in this way. Kölliker, in a later generation, discovered cartilage cells in the synovial villi, and with Rainey evolved the theory of loose bodies being produced from this tissue. We shall see later that these three men—Monroe, Hunter, and Kölliker—between them traced out the three main sources of loose bodies.

Because of the work of Kölliker and Rainey, the theory of the derivation of loose bodies from the articular surface fell temporarily into disfavor. Later investigation showed, however, that in many cases the body resembled a portion of the articular surface so closely that source therefrom could not be denied. Sir James Paget believed that no force could detach such pieces from living bone, and concluded that they were exfoliations of injured portions of the cartilage, after necrosis and without acute inflammation. König, although not denying a traumatic origin in some cases, considered that the majority were detached by a dissecting osteochondritis, but admitted that his examinations had revealed no trace of a morbid process.

Coming back to the years following Hunter's death, William Hey, of Hunter's own hospital—St. George's—carried on the work and in 1803 published his observations. He recommended the trial of a well-fitting kneecap before resorting to operation, because of the then-serious danger of joint infection. He coined the term "internal derangement of the knee-joint" and described the condition as he had seen it, because "he was not acquainted with any author who had described the disease or the remedy."

In his description of the reduction of a derangement he states that he grasped the thigh with one hand and the lower leg with the other. He then gradually extended the knee, and in the course of this extension

suddenly flexed it to the extreme. He says—"This operation I repeated once, and whatever may be the thought of my theory, my practice proved successful." If we could step backward through the interval of one hundred and twenty years, we might be able to supply him with the "thought of his theory." Hey's treatment of derangements was entirely non-operative and he failed to follow-up his reductions with prolonged immobilization, so essential in obtaining a satisfactory result. The introduction of aseptic surgery in 1840 reduced the danger of operative infection, but the inactive mode of life of the average individual of this period made knee derangements necessarily few.

D'Arcy Power, whose Hunterian lecture supplied part of the historical data given above, gives a graphic picture of the conditions during the Regency and early Victorian periods which held up for a time the development of this line of work. His point is that the Englishman of those periods did not put severe enough strain on his knees to displace a semilunar cartilage. The man-about-town played billiards and flexed his knee more severely at his favorite bar than anywhere else. The cricketer was not a very active athlete, when he wore a top hat as part of his costume. "Young ladies took only a minimum of exercise and considered it indelicate to have an appetite. They lounged and sewed, read novels and fainted on the slightest provocation."

The development of coal-mining, the rapid spread of all forms of athletics, and finally the Great War have all instituted a fresh assault upon the finely adjusted structures of the knee-joint. And so it came about that the surgeon again championed the cause of the deranged knee, and has been especially active since the year 1914. During the first decade of this century his fear of operative joint infection very properly dwindled, as he improved his technique and saw the good results obtained thereby. He thus had an unrestricted field of operation when the Great War threw its mass of knee cases upon his hands.

SURGICAL ANATOMY.

The description will be limited, as far as possible, to those structures involved in internal derangements.

Surface Anatomy.—With the knee flexed to a right angle, the patella stands out most prominently, and to either side of it are lesser projections—the femoral condyles. Below each condyle is a corresponding outflaring of the tibia—the tibial tuberosities. An inch and three-

quarters ($4\frac{1}{2}$ cm.) below the patella is the tibial tubercle, with the patellar tendon inserted into it.

On the external aspect of the knee is seen the prominence formed by the head of the fibula, with the tendon of the biceps running to it. In a corresponding position on the inner aspect of the knee, three tendons can be palpated. That of the semitendinosus is the most prominent. Between it and the inner femoral condyle are those of the gracilis and semimembranosus, the former lying between the other two. (The terms "mesial" and "lateral" are now being used to some extent for "internal" and "external," respectively.)

The joint line lies three-quarters of an inch (2 cm.) below the patella with the knee flexed to a right angle, and passes along the lower border of the depression seen on either side of the patellar tendon.

Type of Joint.—We conceive of the knee as a hinge joint modified in two ways: In the first place, there is a slight outward rotation of tibia on femur as the joint swings into full extension, thereby screwing the joint into a more stable structure than it would be otherwise. In this rotation, the external portion of the joint acts as the center, and the inner femoral trochlea describes an arc over the corresponding tibial surface. In the second place, some rotation, both internal and external, of tibia on femur is allowed in all positions of the joint except in the complete extension just described. Slight antero-posterior motion is also possible when the joint is flexed.

Capsule.—The capsule is a sleeve of fibrous tissue completely surrounding the joint, except posteriorly in the intercondyloid area, in which place it is deficient. The tibial attachment throughout, and the posterior portion of the femoral, lie close to the edge of the articulating surface. The anterior and lateral portions of the femoral attachment lie half an inch ($1\frac{1}{4}$ cm.) or more above the margin of the articulating surface.

Supporting Structures.—The joint is supported on all four sides by ligaments, muscles, tendons, and their aponeurotic expansions.

On the internal aspect, and situated nearer the back than the front of the joint, is a broad, membranous band called the internal lateral ligament. It is attached above to the internal femoral condyle just below the adductor tubercle and below, to the internal condyle and adjacent surface of the tibia. It is intimately associated with the capsule and the internal semilunar cartilage. On the external aspect

of the joint is a round, fibrous cord called the long external lateral ligament. Its upper end is attached to the external femoral condyle and its lower, to the head of the fibula. These attachments lie nearer the back than the front of the joint, corresponding to the internal lateral in this respect. The ligament is not attached to the capsule nor to the external semilunar cartilage. Its fibular attachment lies between the halves of the insertion of the biceps. The short external lateral ligament is an inconstant bundle of fibres lying posterior and parallel to the long ligament, and with corresponding attachments. It is closely associated with the capsule.

On the posterior aspect of the joint is a strong sheet of tissue, stretched between femur and tibia and called the posterior ligament. Above, it is attached to the upper extremity of the intercondyloid fossa, and on both sides of the fossa is attached just outside the femoral articular surface, in conjunction with the joint capsule. Its tibial attachment, too, is blended with the joint capsule. It has a superficial portion derived from the tendon of the semimembranosus at its insertion. This bundle of fibers runs from the medial condyle of the tibia obliquely upward and outward to the lateral femoral condyle and is known as the posterior ligament of Winslow.

In front, the joint is supported by the patella and its tendon and the fibrous expansions derived from the vasti and lying on either side of the patella. On all its other aspects as well, the joint is thoroughly supported by muscles, tendons, and their expansions. The ham-strings, gracilis, sartorius, gastrocnemius, and popliteus all take part, but the quadriceps extensor plays a more prominent part than the rest.

Semilunar Cartilages. Two functions—great strength and range of motion—are required in the knee joint, and it is because they tend to be mutually exclusive that a somewhat complicated mechanism is required. Nature's answer to this problem is the partial interposition, between the articulating bony surfaces, of two semilunar cartilages, so arranged that they slide centrally when the joint is flexed and peripherally when it is extended, thus keeping the articulating surfaces in contact at all times and thereby maintaining a stable joint.

The means by which they thus slide back and forth at the proper time is interesting: All four extremities of these cartilages are attached firmly near the middle line of the joint. The portions of the cartilages between these extremities, on the other hand, are attached to the joint capsule. By these means, there is a constant pull inwards on the part of the attached extremities and outwards by the intervening portions.

But the pull inwards is the stronger, and so the cartilages are held in apposition with the femoral articular surfaces. (Barker.)

If now, the quadriceps contracts, it extends the joint and at the same time draws the capsule tense. The capsule transmits this pull to the semilunars, and draws them out of harm's way as the joint is extended. And vice versa, when the quadriceps relaxes, it allows the knee to flex and the semilunars to slide centrally again. The attachment between capsule and semilunar is close to the tibial attachment of the capsule. The intervening portion of capsule is called the coronary ligament. It allows a slight range of motion on the part of the semilunars, in that they can be lifted a quarter of an inch (½ cm.) from the tibial surface.

The semilunars also perform another important function—that of a buffer when the femoral and tibial surfaces are pressed suddenly together. Structures performing a similar function are found in the other supporting joints—the cotyloid ligament in the hip, and the mortise formed by tibia and fibula in the ankle-joint.

It should be noted at this point, that the anterior extremity of the internal semilunar has a dual attachment: the outer portion is continuous with the transverse ligament—a band of tissue extending across to join the external semilunar; the inner portion is attached separately to the tibia. This point helps to explain longitudinal fractures of the cartilage.

Crucial Ligaments.—The crucial ligaments are short, thick ligaments running between femur and tibia, and performing several functions, the most prominent of which is antero-posterior stabilization. The anterior crucial is attached, at its lower extremity, to the anterior intercondylar area of the tibia and the adjacent portion of the tibial spine. It passes upward, backward, and outward, to be inserted far back in the intercondylar notch of the femur, on the internal surface of the external condyle, thus preventing anterior displacement of the tibia and helping to prevent hyperextension of the joint. (The two lateral ligaments are the other limiting structures.) The posterior crucial is attached, at its lower end, to the posterior intercondylar area of the tibia and to adjacent structures. It passes upward, forward, and inward, crosses the other crucial internal to it, and is inserted far forward in the femoral intercondylar notch on the outer surface of the inner condyle, thus preventing posterior displacement of the tibia.

The anterior crucial is especially tense in full extension, and the posterior in full flexion. In intervening degrees of flexion, both are

slightly relaxed. This explains the slight antero-posterior motion possible in moderate degree of flexion. But the crucials also aid in preventing lateral mobility and ab- and adduction. In abduction with the knee fully extended, the internal lateral ligament takes the full strain. With the knee moderately flexed, the anterior crucial receives some of it. In adduction, it is the external lateral ligament and posterior crucial that function. Both crucials play a part in limiting internal rotation, by pressure against each other at their point of crossing. (The other limiting structure is the internal lateral ligament.) They do not take part in limiting external rotation, which is governed by the lateral ligaments.

Tibial Spine.—The tibial spine should be described in connection with the anterior crucial ligament, because of its association with it in certain derangements. The spine is an intercondylar bony eminence with a prominent tubercle on either side. The inner of these tubercles gives attachment to fibers of the anterior crucial, and for this reason it may be avulsed when great stress is thrown upon the crucial.

Fat-pads.—The infrapatellar fat-pad requires mention because of its enlargement at times to pathological proportions. It lies beneath the patellar tendon, is of considerable size, and fills in the dead space in this portion of the joint. It functions as a cushion. Other, smaller fat-pads lie at different places in the joint and have a similar function. Fibres have been traced by Tenney from the alar ligaments into the infrapatellar fat-pad and are believed by him to pull up the pad on extension of the joint, thus keeping it from injury between the articulating surfaces.

Synovial Membrane.—This membrane invests the whole of the articular cavity. It is reflected over the semilunar cartilages, the infrapatellar fat-pad and the crucials on their anterior and lateral aspects. It does not extend around to the posterior surface of the posterior crucial. It is prolonged upward upon the anterior surface of the femur in the form of a pouch. This pouch is supported, during extension of the knee, by the subcrureus, a small muscle arising from the anterior femoral surface and being inserted into the upper part of the capsular ligament. The synovial membrane is also prolonged backwards, on either side of the crucials, to the posterior portion of the joint and is then extended upwards between the femoral condyles and the heads of the gastrocnemius. In this way it forms two separate pouches connected with the anterior synovial chamber by narrow passages—so narrow as to exclude

the transit of a body much larger than a dried pea (3/16 in. or ½ cm. in diameter.) Fibres of the gastrocnemius are attached to the capsule adherent to these pouches, and thus take up the slack in the capsule and synovial membrane when the joint is flexed (Tenney).

In the infrapatellar region, the synovial membrane sends off a triangular fold which partially crosses the joint and enters the intercondylar notch, at which point it is attached. Prolongations from this fold extend forward and laterally to the capsule. The free edges of these prolongations brush the femoral trochleae as the joint is moved, thus aiding in lubrication. They are called the alar ligaments. The triangular fold of membrane from which they spring is the "ligamentum mucosum." When the joint is extended, the pull upon the capsule is transmitted to the ligamentum mucosum and the alar ligaments, thus preventing the latter from being injured between the articulating surfaces.

Articular Cartilage.—One other feature should be mentioned—the articular cartilage of the femoral trochleae—for it is this area especially which is apt to give off cartilaginous flakes under certain conditions.

Summary.—These structures—the joint capsule with its supporting ligaments and tendons, the semilunar cartilages, the femoral articular cartilage, the crucial ligaments, the tibial spine, and the synovial membrane and infrapatellar fat-pad,—are the structures involved in internal derangements of the knee. Together they make up a joint remarkable for its combination of strength with range of motion, a combination due to the shape of the articulating bones, the interposition of semilunar cartilages, the admirable ligamentous protection both inside and out, and the close apposition of hard and soft structures in all positions of the joint.

ETIOLOGY.

Internal derangements, because of the traumatic element in their etiology, are found much oftener in the male than in the female, a ratio of ten to three in our series. Derangements of the internal semilunar cartilage have been reported more frequently in the British Isles than in this country, and this occurrence may also be explained in part by the traumatic element in sports and coal-mining. It may be, too, that not until recently was the condition so readily recognized in the United States.

At least one condition causing derangements, hypertrophic arthritis, has had a broad field of activity in the human race, both in time

and place, and even visits the lower animals. Bones of the ancient Egyptians have shown its characteristic changes, and the same has been found true of domestic and wild animals of the present day. Its frequency in modern man is graphically shown by outpatient clinics in any large city and by the autopsy findings in subjects past middle life.

It is of some value to know the relative frequency of the different types of cases coming to operation in hospital wards. The figures for the Massachusetts General Hospital between the years 1900 and 1920 are:

Internal Semilunars		43.1%
External Semilunars		8.3%
Loose Bodies		22.7%
Hypertrophic	Fringes	13.8%
"	Fat-pads	5. %
"	Bone	2.8%
Crucial Ligaments		1.7%
Fibrous Bands		1.7%
Chronic Arthritis		1.1%

Trauma, torsion, and toxin are the offending agents. Severe torsion of the knee, in work or play, is the cause of injury to the internal lateral ligament, the internal semilunar cartilage, and the crucials and tibial spine. Less frequently, direct trauma may cause injury to the crucials and tibial spine. Trauma or torsion also produce at least the majority of derangements of the external semilunar cartilage.

Trauma, toxin, and nutritional disturbance are offered by different investigators as the cause of flakings off of the articular cartilage.

The first theory is sponsored by Timbrell Fisher, who supports it by clinical, pathological, and experimental data as follows:

Clinical Data.—Twelve out of thirteen cases in his series had a traumatic history, and in the thirteenth case, microscopic examination of the specimens showed perfectly healthy cartilage and bone cells. Lack of traumatic history may be due to the loose body being of an hypertrophic arthritic origin or to lack of questioning regarding indirect trauma.

Pathological Data.—Examination of the deep surfaces of the specimens showed in many cases the appearance of a fractured surface, and in all cases a freedom from any evidence of granulation of fibrous tissue, or of pitting due to phagocytic action. The specimens composed

only of cartilage showed the cells healthy throughout. In those composed partly of bone, the bone cells were dead, but had evidently died after and not before detachment. (The same behavior of bone cells is observed in experimental grafting.) The site of origin of the body, when it could be determined, was one of the portions of the surface most exposed to injury. The areas around the femoral attachments of the crucials were considered to be subject to injury by severe tension on the crucials.

Experimental Data.—The author has detached portions of the articular surface in the cadaver, by a moderate blow with a hammer upon the lateral margin of the condyle and by putting severe tension on the crucial ligaments. He has also produced a traumatic loose body in a rabbit, the microscopic characteristics of which were almost identical with museum specimens from the human subject.

The second theory—toxins as the cause of flakings off of the articular cartilage—is sponsored by Colvin. This investigator believes that the condition is due to an infectious osteitis. In his cases, he often found no history of trauma. The pain, of an aching character, persisted for some years before there was any real impairment of function. X-rays taken during this time showed localized alteration in the articular surface, from the region of which the foreign body later emerged. He believes that the symptoms are due to a low grade of inflammation and that there is strong presumptive evidence for considering the condition a non-suppurating osteitis.

The third theory—that of nutritional disturbance—has been suggested by Axhausen. He believes that in so-called osteochondritis dissecans, trauma is the important element. But he observes that in the cases in which operation has been performed soon after a trauma, and separated bone found, the microscopic findings suggest a process antedating by a long time the last trauma. In his own case, the process was almost entirely one of resorption, with very active connective tissue and with giant cells eroding the surface of the necrotic bone, findings in marked contrast to those of Fisher, given above. He therefore suggests the hypothesis that the dissecting process may be due to an embolus, perhaps a tuberculous one, and that trauma only completes the separation.

In connection with the last of these theories, we report that certain cases of extreme arteriosclerosis have shown suggestive changes in the surface of bones, notably the sacrum, on x-ray examination. These changes consist of localized areas showing loss of bone substance.

Other types of loose bodies are produced from the synovial fringes and from bony overgrowths in hypertrophic arthritis. In regard to the former, we know that cartilage cells are present in the synovial fringes and that these fringes are derived, embryologically, from the same cartilaginous bar which becomes cleft to form the knee-joint. Another etiological point is that synovial chondromata are often associated with a history of injury and seem to occur frequently in chronic synovitis. They are true neoplasms, however, and the full secret of their etiology is therefore unknown.

In regard to hypertrophic arthritis, the etiology is still obscure. Fisher believes the condition to be the result of prolonged or often-repeated injury, either mechanical or toxic, but of a moderate degree of intensity. He supports the theory of infectious foci as being an etiological factor, in certain cases, and believes that the future will bring to light additional causative agents, such as disorders of the ductless glands. He supports the theory regarding the bacterial toxin group by clinical, pathological, and experimental data.

Ely concludes, from all the evidence at his disposal, that the disease is not of bacterial origin. He states that although all the evidence is against a bacterial etiology, yet the whole appearance of his specimens indicates that an infection of some sort is the cause. He considers a protozoan, most likely the amoeba histolytica, to be the first choice among the possible infecting organisms.

Nichols and Richardson present strong evidence that infectious foci and inflammation play little or no part in the etiology.

Trauma and toxin both enter into the production of hyperplastic changes in the synovial fringes and the infrapatellar fat-pad. If trauma, the initial injury usually comes from without, and may consist of one moderately severe stroke, numerous minor ones, or merely prolonged kneeling as is required in some occupations. The tissue having once been injured and congested, is increasingly subject to trauma thereafter, between the articular surfaces.

If toxin is the causative agent, it produces inflammation and congestion, with the resulting nippings between the joint surfaces described above.

SURGICAL PATHOLOGY.

We have reviewed the normal structure of the knee-joint and shall now view this region after it has been laid waste by the three furies of trauma, torsion and toxin.

Mechanism of Injury of the Internal Lateral Ligament, Internal Semilunar Cartilage, and Crucial Ligaments (Alwyn Smith).—Dislocation or fracture of the internal semilunar cartilage is the most common lesion found in the derangements. It is produced by strong internal rotation of femur on tibia when the knee is in a flexed position. When this rotation takes place, the semilunars first slide internally over the tibial surface, as far as their small range of motion will allow. (All normal rotation of the knee takes place between semilunars and tibia.) If this rotation continues to an abnormal degree the deep fibres of the internal lateral ligament are torn, usually at one extremity and more often at the tibial than the femoral. They may bring a fragment of bone away with them, producing a "sprain fracture."* Further rotation involves a tearing loose of the internal semilunar at its periphery or extremities, or a fracture of the cartilage in a longitudinal or transverse direction.

The next structure after these to receive the strain is the anterior crucial ligament. It may be merely stretched, or may be ruptured. Partial or complete avulsion of the tibial spine, to which the ligament is attached, may take place, either separately or in conjunction with injury to the ligament. As a final step, usually preceding dislocation of the joint, the posterior crucial may be ruptured.

Details of the Pathology of the Internal Semilunar Cartilage and Mechanism of Production.—Reports vary regarding the type of internal semilunar injury seen most frequently at operation, but it seems to lie between a fracture, a longitudinal splitting of the cartilage, and a dislocation, a tearing loose of the anterior end. The other prominent type of fractured cartilage is the transverse, occurring opposite the internal lateral ligament, or in the anterior third.

Besides the dislocation of the anterior extremity, there may be a similar situation at the posterior, or a partial tearing loose of the periphery of the cartilage from the capsule. In the latter case, attempted extension of the knee no longer draws the semilunar sufficiently far towards the periphery, for the connection between capsule and semilunar has been partially severed, and hence locking is apt to occur. This peripher al separation of the cartilage is probably the most frequent of all lesions of the internal semilunar (Barker, Vulpius), but is

*In the case of a sprain fracture, the femoral extremity is involved oftener than the tibial. X-ray shows a small, bony film separated from the femur in the vicinity of the adductor tubercle. If the tibial end is involved, the bony fragment is apt to include part of the articular surface.

not the one most frequently seen at operation, because of the comparative mildness of the symptoms. In other words, a patient sustaining this degree of semilunar injury is not seriously disabled. Locking, if present, is only momentary. The patient does not receive adequate treatment, and healing takes place with the semilunar in this relaxed position and pulled centrally by its extremities. Hence a second injury, similar to the first (i. e., inward torsion with the knee flexed), may cause a severe catching of the cartilage between the joint surfaces, with a consequent fracture or tearing loose of one of the extremities. It is after this or subsequent lockings that operation is performed.

The longitudinal fracture referred to above is probably the result of one of these secondary injuries. The semilunar, because of its relaxed condition, becomes caught between the articulating surfaces. Ensuing torsion pulls on its periphery, while the pressure of the femoral trochlea, especially upon its central fibres, holds it back. The result is a longitudinal split beginning near its anterior extremity, between the peripheral fibres, which are continuous with the transverse ligament, and the central fibres, which are attached separately to the tibia. This anatomical point was first brought out by Billington. If the cartilage is torn longitudinally, the inner portion generally slips centrally, but remains attached at its extremities. It thus roughly resembles an old-fashioned bucket-handle and the type is so designated.

In the case of a free extremity, the locking is most likely due to a slipping centrally or a buckling over of the injured part.

Bizarre forms of the above lesions occur, such as the nodular type of loosened anterior extremity. The cartilage in general may show different degrees of alteration due to long-continued trauma or other causes, and cases have been found in which the cartilage has disappeared entirely (Jones).

Details of the Pathology of the External Semilunar Cartilage and External Lateral Ligament.—Mechanism of Production.—The mode of production of external semilunar injuries is not so clear as in the case of the internal. But in view of the fact that its structure is in general similar to its mate and the pathology found at operation similar to that found in the internal semilunar, it is most likely that the modes of production are similar. In the series analyzed by the writers, reports were obtained in 15 cases. Nine of these had a definite history of injury and six did not. Of the nine, four were due to trauma, four to torsion, and one to acute flexion. (A longitudinal splitting of the cartilage). (A tearing loose of the anterior end).

Descriptions of the operative findings in external semilunar injuries are hard to find in the literature, and on this account the findings in the above series will be described. A summary will first be given followed by some details:

Summary—

2 Fractured
- 1 Transverse
- 1 Longitudinal

13 Not Fractured
- 5 Involvement of Anterior End
- 3 Looseness and Displacement of Whole Cartilage
- 1 " without Displacement
- 1 Detachment of Cartilage with Rolling up of Inner Edge
- 1 Disc-Shaped Outgrowth from Anterior Portion
- 1 Abnormally Thickened
- 1 " Prominent

Only two of the fifteen showed a fracture, one transverse near the anterior attachment and one longitudinal, producing the "bucket-handle" type. Of the thirteen remaining, five showed various involvements of the anterior end, each somewhat different from the other four. One of these had merely a free end, one a thickened end tilted up, one a folded end with a general loosening of the whole cartilage, one had the anterior end dislocated backwards and one showed a projection, perhaps a cyst.

Three showed general looseness and displacement of the whole cartilage, one forward, one backward, and one peripherally. One showed general looseness without any displacement. One showed detachment of the cartilage with a rolling up of its inner edge. One had a disc-shaped projection growing centrally from its anterior portion. Of the two remaining, one was described as thickened and the other as prominent.

One case, not included in our series, showed a presumable cyst arising from the external semilunar cartilage, as described by Phemister and others. The growth constituted an external and not an internal derangement and for this reason was not included in the series. The case will be referred to under "Operative Data" in the report of cases.

An anatomical explanation has been offered for the great preponderance of internal semilunar injuries over those of the external. This is the small range of motion possible in the former, when compared with the latter. The internal cartilage is attached more extensively at the periphery, and its extremities lie further from each other than those

of the external. On this account, there is less "give" when violence is applied to the internal, and its factor of safety is smaller (Jones, Lancet, 1914).

But there is also a physiological feature which helps to explain this situation—the preponderance of torsions inward over torsions outward, on the part of the athlete or worker. The athlete turning suddenly in running and the miner turning to throw a shovelful of coal into a car, both turn towards the opposite side and throw the body weight to the other leg. If the individual turns towards the same side, he must throw his free leg across the other, in order to keep his balance. The latter method of turning must, of course, be used at times, but it is awkward and is not the motion of choice. We know that it is internal torsion rather than external which produces internal semilunar injuries. Assuming that a corresponding torsion, i. e., external, produces external semilunar injuries, we thus have an additional explanation for the comparatively small number of these lesions. In the cases in which direct trauma is given as the cause, it may be said that the inner portion is more exposed to direct injury than the outer, both because of the natural manner of maintaining balance described above, and because of the prominence of the inner portion of the knee.

In regard to the external lateral ligament, its pathology is similar to that of the internal, the tibial extremity being the part most frequently injured.

Details of the Pathology of the Crucial Ligaments and Tibial Spine.—Mechanism of Production.—In regard to rupture of the anterior crucial ligament or avulsion of the tibial spine, it seems to be a matter of relative strength which of these two lesions will occur. Both may occur together. A rupture of the anterior crucial seems to involve the femoral attachment more frequently than any other part. The usual picture presented by such a rupture shows only a small fragment of the ligament remaining, the rest having disappeared.

Because of the intimate association of the extremities of the external semilunar with the spine of the tibia, these extremities may become involved in injuries to the tibial spine or anterior crucial. The internal semilunar cartilage is, of course, involved in nearly all cases of anterior crucial injury, because they are both produced by the same type of violence, i. e., torsion inwards or medially, and the former is injured before the latter. Rarely, an anterior crucial injury is produced by forcible hyperextension of the knee.

The fractures of the tibial spine occurring in conjunction with anterior crucial injury are either a fracture of the whole spine or of its internal tubercle. The latter receives the insertion of the anterior crucial ligament and is for this reason the only part of the spine avulsed in certain cases.

Fracture of the external tubercle of the spine also occurs, but this is not associated with crucial ligament injury. It is produced by a rotation inward of femur on tibia, followed by a forward thrust of the femur, whose external condyle sweeps off the bony prominence. The fracture of the external tubercle is therefore preceded by a rupture of the internal lateral ligament and at times by a derangement of the internal semilunar cartilage as well.

Fracture of the external tubercle is in rare cases associated with fracture of the internal tibial tuberosity and vice versa, fracture of the internal tubercle with fracture of the external tibial tuberosity.

Loose Bodies in the Knee.—Timbrell Fisher, whose research on this subject has been referred to before, concludes that loose bodies are produced in three different ways: (1) by a more or less generalized pathological process, such as hypertrophic arthritis, tuberculosis, tabes, or arthritis due to infection; (2) by localized violence to an otherwise normal joint surface; and (3) by the formation of chondromata from the synovial villi. He describes these groups as follows:

(1) Bodies produced by hypertrophic arthritis are of two varieties: synovial chondromata (identical macro- and microscopically with those which he describes under that heading), and osteo-cartilaginous bodies. The latter come from various points of the articular surface, as fractured hypertrophic nodules, but especially from the periphery. The femoral and patellar surfaces are by far the most apt to produce these bodies. They show on section a bony center surrounded by a cartilaginous zone. On microscopic examination, the bone is seen to be dead. There is a zone of living cartilage cells around it, and outside of this a peripheral zone of fibrous tissue. Grossly, the body may show a narrowing at one extremity, indicating its previous point of attachment. It is unusual for more than two or three of these bodies to be found in the joint, but they may co-exist with synovial chondromata of varying numbers. By these macro- and microscopic features, the source of the body can be determined.

Bodies produced by tuberculosis come more frequently from the femoral surface than from the patellar or tibial. They are probably produced by interference with the blood supply of the affected portion.

and this may account for their wedge-shaped form. It is interesting to compare this theory with that of Axhausen, given above, as to the possible etiological factors in so-called osteochondritis disseeans.

(2) This is the group of bodies found in joints whose appearance is otherwise normal. They occur more frequently in males than in females and come especially between the ages of fifteen and twenty-five years. Their source is the articular surface of femur, patella, or semilunar cartilage. It is rare for them to come from the tibial surface.

Bodies Derived from the Articular Surface of Femur or Patella.—The particular localities most apt to produce them are those portions exposed to injury by severe traction on the ligaments or by direct trauma. The portions most frequently involved, therefore, are the areas adjacent to the femoral attachments of the crucial and posterior capsular ligaments, and the exposed portions of the femoral trochleae. They occur in different varieties.

The commonest is a circular or oval, almond-sized, osteo-cartilaginous body, with a plane surface on one side and a convex on the other. When this fragment lay in its normal place, the plane surface lay deep, in apposition with the tissue from which it was broken off, and this surface accordingly shows different degrees of roughness, altered by the degree of proliferation that has taken place since its fracture. (In contrast to this finding, Axhausen reports a specimen which showed active connective tissue and giant cells eroding the surface. Colvin reports the cavity from which a fragment had escaped as presenting a raw, bleeding surface appearing like granulation tissue, and the surrounding bone as being indurated. He considered these appearances suggestive of chronic bone infection.) The convex surface has the typical appearance of articular cartilage. The edge is smooth and rounded, due to the growth of cartilage over it. Cross section shows a thick zone of cartilage on the convex side and bone on the plane. The cartilage has grown to a certain extent over the edge and upon the plane, bony surface. Microscopic examination shows the cartilage cells to be alive, but nearly all, or all, of the bone cells to be dead.

Other varieties of this group are similar to the above, except that they show different degrees of cartilaginous proliferation, from the fragment so recently separated that it shows no proliferation, to the veteran, thickly studded with hyperplastic nodules. There is one more variety of the femoral or patellar articular surface type and this is put in a class by itself, because it is the only one showing the formation of new bone. Bodies of this variety all show incomplete detachment

from the parent tissue, or secondary attachment to fresh tissue. The explanation is that the osseous tissue gets its nourishment through these attachments, while cartilage does not require attachment to any structure for its survival.

Bodies Derived from the Semilunar Cartilages.—These bodies most frequently come from the anterior extremity of the internal cartilage. Occasionally, the posterior extremity of the internal or one of the horns of the external cartilage gives off the body. It may be either attached by a pedicle or lie free in the joint.

Bodies derived from the articular surface of bone or cartilage usually occur singly, but two or three may be present. They are occasionally bilateral. Regarding their location in the joint, bodies originating in the anterior chamber are pretty sure to stay there, because of the small calibre of the passages leading to the posterior chambers. A body may lodge behind the anterior crucial ligament and escape detection, unless special search is made for it. The knowledge of this point may prevent the dilemma of the hunter for eggs on Easter morning.

(3) This group comprises chondromata derived from the synovial villi. They may be either single or multiple, and pedunculated or free. One type shows numerous small bodies scattered through the synovial fringes, resembling a type of sea-weed familiar to the Atlantic coast.

The single bodies are larger than the multiple, and tend to occupy recesses in the synovial chamber. On account of both of these features, they rarely slip in between the articulating surfaces, and are often discovered accidentally post-mortem. The diameters of two such reported specimens were one and two-fifths inches ($3\frac{1}{2}$ cm.) and three-quarters of an inch (2 cm.) respectively.

Multiple chondromata may occur in great numbers, one case having yielded over one thousand at operation.

Hypertrophic Synovial Fringes and Infrapatellar Fat-pad.—The term "hypertrophic," applied to these soft tissues and used frequently throughout the paper, does not imply any bony change. Hypertrophied fringes and fat-pad are closely associated. Their mode of production is the same, i. e., trauma with or without toxin, and their pathology similar. They often occur together.

In regard to the fat-pad, the primary pathological picture is usually a bruising and congestion, often with extravasation of blood, from external trauma. This congested, enlarged condition of portions of the

pad causes the free edges readily to slip in between the articulating surfaces and sustain injury. The more trauma they receive, the larger they grow, and thus enter into a vicious circle. The pathological picture, therefore, varies according to the duration of the trouble. The earliest cases show a normal color or a reddish-yellow tinge. Blood clots may even be found. The later cases show different degrees of granulation and fibrosis. Cross section of the specimen may show varying degrees of fibrosis, and also hemorrhagic points and distended vessels. Microscopic examination shows reduction in the amount of fat, sometimes with necrosis, and its place taken by a fibrous tissue (Hoffa). The endothelial cells of the synovial membrane may therefore lie in apposition with the fibrous stroma of the pad, and without any intervening fat.

A tear in the synovial covering of the pad may result in a herniation of fat into the joint and, because of repeated trauma, an exuberant growth of various portions of the mass which finally produces an arborescent appearance. Such an "arborescent lipoma" is commonly located in the upper, outer portion of the anterior compartment. It may grow large enough to fill the joint and distend the capsule.

Certain individuals, especially those who show an unusual amount of fat elsewhere in the body, have unduly large infrapatellar fat-pads. These pads, because of their size, may receive a primary injury between the articulating surfaces, without having sustained any external injury.

The fringes involved are usually outgrowths from the alar ligaments. Their hypertrophy is due to an initial injury or to toxic action with subsequent traumata from the articulating surfaces, just as in the case of the fat-pad. The result is a congestion and elongation of the fringes, with a variable amount of inflammatory and fibrous change.

Hypertrophic Bone.—Timbrell Fisher's article was the source of the following data, and should be consulted if more details are required.

These bony changes are produced by hypertrophic arthritis and may show themselves as lippings or nodular outgrowths of the articular cartilage, especially of the femur or patella. A nodule may break off, forming a loose body in the joint. This condition has been described in the discussion of loose bodies.

The most striking feature of the early changes in an hypertrophic joint is the apparent fibrillation of the central portion of the articular cartilage. This change, on closer examination, is seen to be merely a splitting of the matrix, without fibrous metaplasia and is believed (by Fisher), to be due to the percolating of toxins through the meshwork of the superficial structure. This is the same path followed by the synovial

fluid in reaching these tissues. After this change appear lippings at the periphery, due to chondrous proliferation. These reactions are, of course, in marked contrast to each other, and are explained by Fisher on structural and nutritional grounds; structurally, the peripheral portion of the cartilage is furnished with a perichondrium, while the central portion is not. Physiologically, the periphery receives blood from the vascular circle of the joint, graphically shown in one of his illustrations, while the superficial layer of the central portion has only the synovial fluid to draw upon.

The peripheral outgrowths gradually increase in size and are invaded by osseous tissue from beneath. Similar outgrowths develop in the more central portions of the articular cartilage, the first stage of their formation being localized hyperplasia in the deeper portions of the cartilage, in which nutrition is obtained from vessels in the cancellous bone beneath. These hyperplastic areas are invaded by osseous tissue and then in some way become separated from the surrounding cartilage. One explanation offered as the mode of separation, is a fibrous metaplasia at the line of demarcation. These bodies finally appear as nodular outgrowths in the articular surface. Both peripheral and central outgrowths may become large enough to interfere with function, but they are much less likely to do so if the joint is put through its full range of motion daily.

The degenerating cartilage in the central area finally disappears and exposes a hard, eburnated bony surface. The sclerosing process in the bone begins before the cartilage is entirely worn off and is probably in the nature of a protective reaction.

Synovial changes begin when the peripheral lipping first appears. A thickening of the soft tissues adjacent to these lippings takes place, and a general increase in the size and number of the synovial villi. (This villous hypertrophy, however, is not nearly so prominent a feature in hypertrophic arthritis as it is in the atrophic and infectious arthritis of Goldthwait or the proliferative arthritis of Nichols and Richardson.)

Opinions differ regarding the question of increased vascularity. Fisher states that the involved portions appear unduly vascular, while Swaim states that there is no increase in the vascularity. The synovial villi at this stage may give rise to chondromata, as described previously. In a later stage, the villi undergo secondary changes and the membrane becomes smooth and atrophic.

Summary.—The pathological picture is therefore one of violence, slow change, or both combined:—violence in the case of injured internal lateral

ligament, semilunar cartilages, tibial spine, crucial ligaments, and loose bodies derived from the articular surfaces; slow change in the case of synovial loose bodies and hypertrophic bone; both combined in the case of hypertrophic soft tissues.

SIGNS, SYMPTOMS, AND DIFFERENTIAL DIAGNOSIS.

We believe that by far the best way to present signs and symptoms is by means of actual case histories. By this means we hope to present the different aspects of the problem more graphically, perhaps relieving tedium at the same time by means of the personal element. We shall, therefore, cite cases of each of the different types of derangement, and beneath them discuss other features not illustrated by these cases. We realize that the case histories are not so complete as one could wish, but the discussions cover those points omitted by the busy interne. We shall conclude each case with the differential diagnosis.

Internal Semilunar Cartilage.—A boiler-maker, 31 years old, was admitted in June, 1917, complaining of recurrent locking, pain on standing up and starting to walk, and inability to fully extend his knee.

Ten months previously, he had wrenched his knee while running on the beach and was unable to use it for three weeks. During that time he had swelling, stiffness, and limitation of flexion, but not very much pain. He had no more trouble for four months, when he slipped on the ice and suddenly hyperextended his knee, causing a recurrence of the pain. He obtained some relief by the application of a liniment. Four months later, he wrenched the knee again and was referred to the outpatient department.

The record further states that since the onset of the trouble he had had several attacks of locking, always with swelling and pain for several days afterwards. The limitation of flexion following the first injury was presumably one of these occasions.

Local examination showed a normal-appearing knee, with no evidence of fluid. A small, tender area was found in the joint line just anterior to the internal ligament. Flexion was normal but extension was limited five degrees.

X-ray in the antero-posterior plane showed a small, dense, calcified mass just below the patella and an irregularity in outline of the upper surface of the tibia. There were hypertrophic changes in the joint as well. Diagnosis.—Probable fragment of displaced semilunar cartilage.

Discussion.—It would have been of value to know more about the nature of the lockings, whether they came as a result of mild torsion, were accompanied by a sickening pain and persisted for a time with perhaps some difficulty in reduction, or whether they came without warning, were only moderately painful, and were of a transitory nature. The former would have suggested a semilunar; the latter, a loose body.

There was probably no palpable mass present at the times of locking, or there would have been a statement to that effect. We assume also that on examination no hypermobility was found, either laterally or in the antero-posterior direction. This question of hypermobility is a very important point, for by this means an injured lateral or crucial ligament may be diagnosed, and more inclusive treatment employed. Details of hypermobility in crucial injuries will be given under that heading.

The x-ray findings rarely give us positive information in a case of deranged semilunar, by revealing a mass in the semilunar area. The usual findings are negative as far as the semilunar is concerned, and the purpose of the x-ray is to rule out loose bodies. Oxygen or nitrogen inflation of the joint, with subsequent x-ray, has been found to furnish positive evidence in cases of torn semilunar. The gas works around behind the torn portion, thus throwing it into sharp relief against a black background. (Bircher believes this procedure will become as indispensable for knees as cystoscopy is for the bladder. Out of nine cases of lacerated semilunar which he thus examined, the diagnosis was confirmed by operation in eight. The ninth was presumably not operated upon. In another of his cases, a suspicion of tuberculosis was disproved.)

The patient in question was evidently suffering from a recurrent cartilaginous or bony derangement, brought on by wrenching the knee ten months previously. A derangement due to soft tissues would not often have so marked a traumatic onset nor cause such marked symptoms. The probabilities were therefore a semilunar cartilage or a loose body.

In the first place, no loose body had been observed at any time, and in the second, the mode of onset was not typical of a loose body, but was typical of a deranged semilunar. The former usually produces no locking for an interval after the injury, while the latter is apt to produce symptoms immediately. Then the severity and duration of the symptoms following succeeding lockings in this case pointed towards semilunar rather than loose body. A minor point is that the frequency of the former derangement is greater than that of the latter—two and a half times as great, in our series.

Local examination showed tenderness adjacent to one of the two areas

typical of an internal semilunar injury—i. e., the joint line, over the internal lateral ligament and over the anterior horn of the semilunar (Jones). Areas of tenderness in the case of a loose body are not so common nor so constantly situated.

The possibility of the external semilunar being involved instead of the internal was not likely enough even to be considered, in view of the location of the tender area and the general preponderance of internal involvements over the external. Sir Robert Jones places this proportion at nine to one; Martin, at 11½ to 1. Strahlman and White found a proportion of five to one, and our series agrees with the latter. Sir Robert's figures, however, are based on many times the sum total of the last two series.

Operation revealed a loosened and partially free anterior end of the internal semilunar. The cartilage was excised and the patient relieved entirely thereby. He resumed his trade as a boiler-maker.

External Semilunar Cartilage.—A clerk, 30 years old, was admitted in August, 1913, complaining of recurrent attacks of pain on the outer aspect of the left knee, and inability fully to extend the joint.

His trouble dated from seven months previously, when he slipped and twisted his knee, thereby causing much pain and a feeling as if something in the joint were interfering with its full extension. He remained in bed for three days and limped for three weeks thereafter. At the end of that time he voluntarily twisted his knee and felt something slip, thus ridding himself of the limitation and pain.

He had had a recurrence of the trouble four months before entry and had not been able to fully extend his knee from that time on. The pain was always localized on the outer aspect of the knee.

Local examination showed a normal appearance. On palpation, however, a very tender area was found just below the outer edge of the patella.

Discussion.—The story and examination are rather similar to the case with internal semilunar derangement, except that the symptoms are not so severe, and the localization of the pain and tenderness is on the outer instead of the inner aspect of the knee. Eleven of our fifteen cases of external semilunar derangement had pain, tenderness, or discomfort localized on the outer side of the knee, usually at the joint line. One of these had as much tenderness internally as externally. Of the four remaining, two had no pain or tenderness and in two there was no definite statement one way or the other, thus implying no pain nor

tenderness.* Nine had a story of previous injury; six had none.

The only other condition to be considered in this case is the presence of a loose body, and the points pro and con have been discussed in connection with the internal semilunar case.

Operation revealed the "bucket-handle" type of external semilunar derangement, with adhesions. The cartilage was removed, with entire relief to the patient in between six and twelve months. The length of convalescence time was perhaps due to the presence of adhesions. The patient is on his feet about seven hours a day.

We assume that the persistent limitation of extension for four months previous to operation was a permanent locking.

Crucial Ligaments.—A married woman of 36 was brought into the Accident Room by the police, who said that she had been knocked down by an automobile shortly before.

Examination showed her to be in a marked state of excitement, crying out and thrashing wildly about. Both her head and right knee had been injured. The latter showed some ecchymosis, swelling, and marked hypermobility, both antero-posteriorly and on abduction. A chip had also been broken from the inner border of the head of the tibia, as revealed by x-ray.

Discussion.—A history of injuries in these cases helps to exclude cases of relaxed ligaments due to a Charcot joint or to locomotor ataxia (Jones and Lovett). The outstanding feature from the diagnostic point of view is the hypermobility of the joint. The marked antero-posterior mobility shows that one or both of the crucials has been partially or completely ruptured. It is presumably the anterior which is involved, as this is the much more frequently injured one of the two. If the statement had been definitely made whether the tibia could be displaced anteriorly or posteriorly, we could say definitely—the anterior in the former case, the posterior in the latter. (Hypermobility due to anterior crucial injury is more evident with the knee in full extension; that due to posterior crucial injury is more evident with the knee in full flexion.) Two other forms of hypermobility should be mentioned: Internal rotation of tibia on femur, with the knee in full extension, is considered by Sir Robert Jones to be diagnostic of crucial injury and is especially valuable if there is doubt about antero-posterior mobility. The second

*Sir Robert Jones states that symptoms on the outer side of the knee may be produced by deranged internal semilunar and Barker has described internal symptoms being produced by an external cartilage. The logical procedure seems to be to operate on the painful or tender side, other features being equal.

form is lateral "rocking," which is considered by Alwyn Smith to be the main symptom of stretched anterior crucial.

Marked abduction means that the internal lateral ligament must have been injured along with the anterior crucial. X-ray shows us a detail of the nature of this injury, a chip from the tibia at the insertion of the fibres of the lateral ligament. Pressure over the tibial end of the ligament would probably have revealed an especially tender point. The condition is a sprain fracture involving the internal lateral ligament.

The question of fractured tibial spine always comes up in a crucial injury, because such a fracture may obstruct and prevent a good result. The question is answered by attempted extension of the knee and by x-ray. A bony block is the most constant sign of a fractured tibial spine. If extension is complete, there is at least no obstruction, and the question of a fracture without obstruction is answered by x-ray. (There was no fracture of the spine in this case.)

In such an injury as this case shows, there may well be a deranged internal semilunar with locking. The question may then arise whether limitation of motion is due to this condition or to a fractured tibial spine. In the former case, motion is not stopped so abruptly and the obstruction seems to be of a less resistant nature than in the case of a bony obstruction. X-ray is the final court of appeal. Fracture of one of the tibial condyles is occasionally found in a severe injury of the type cited above.

Operation was performed between five and six weeks after entry and revealed injury of both crucials—a complete rupture of the anterior at its femoral attachment and a partial tear of the posterior. The anterior crucial was restored by means of a suture passed through the external condyle to the site of its femoral attachment, then drawn down to the ruptured end and sutured to it. The free end was passed back through the external femoral condyle. The result was poor, not because of hypermobility, but because of marked limitation. This limitation was presumably due to the severity of the injury.

Loose Body. A barber, 48 years old, was admitted in April, 1909, on account of recurrent pain in his left knee and occasional locking.

He had injured the knee six or seven years previously while wrestling, and on occasions since that time had felt a small lump, usually on the inner side of the knee but at times on the outer. By manipulating the lump, after locking had taken place, he could regain motion. He had had considerable pain at times, especially at night.

Examination showed a normal-appearing knee, with a marked, soft

crepitus on motion. No mass could be found. X-ray showed, "At least two loose cartilages in the joint cavity."

Discussion.—Assuming that the patient is a normal individual, a diagnosis of loose body is made on his story alone. The soft crepitus on examination is consistent with the diagnosis, as being probably due to chronically traumatized tissues. X-ray confirms the diagnosis and further indicates that two loose bodies are present instead of one. It does not assure us of the fact, unless we can see the plates for ourselves and make sure that a sesamoid bone has not been mistaken for a loose body. The points indicating a sesamoid are an apparently extra-articular location and a flatness of the deep surface (Henderson). Differential points between loose body and deranged semilunar are given under the latter heading but are not needed in this case.

Regarding the probable source of the loose body, we rule out hypertrophic arthritis because of the negative findings on examination and x-ray. Then too, the patient was only 42 years old at the time of onset of his derangement, a little young to have hypertrophic arthritis. We consider the synovial membrane as a less likely source than the articular surface, because of the definite history of injury and also because of there being only two bodies present at the most. The synovial membrane, while often producing only a single body, also gives rise to various numbers, but the traumatized articular surface rarely gives rise to more than two or three. Multiple chondromata, because of their smaller size, produce more frequent locking than does the body from the articular surface, but the locking is not so severe.

Only one body was found at operation and this was not described sufficiently to identify it as belonging to any one of the three classes. The patient has had no trouble since.

Timbrell Fisher, with a clairvoyant eye, describes the actions of a loose body side by side with the symptoms produced:

A portion of articular surface is completely detached by trauma, wanders freely in the joint for a time and then becomes secondarily attached to the synovial membrane. The symptoms are therefore sudden attacks of sharp pain, often followed by swelling or momentary locking. The first of these attacks comes on almost immediately after the injury, and after a time they disappear.

In another type of case, the articular fragment is completely detached by the injury as in the first case, but almost immediately becomes secondarily attached, and after an interval becomes free again. The patient therefore has a free interval after injury, and then the characteristic attacks.

In still a third type, the articular fragment is gradually detached and at length becomes free. In this case, the process of detachment is accompanied by attacks of pain and swelling, often increasing in severity, and finally the more severe attack.

Hypertrophic Fringes.—A female shoe-worker of 43 was admitted in August, 1904, on account of persistent trouble with her right knee.

Six years previously, she had developed severe, jumping pain in both shoulders and then in all her joints, except ankles and back. There was some sweating during this attack but other symptoms were not recorded. Her right knee had continued to trouble her ever since, by tiring easily, giving considerable discomfort on walking and a feeling of something slipping in the joint, but not locking it.

Examination.—In her left hand, there was thickening of the fourth carpo-metacarpal joint and of both interphalangeal joints in the same finger. Her left knee gave a dry crepitus on motion. Her right knee was considerably enlarged by a thickened capsule. On motion, there was considerable crepitus and "fringes could be easily palpated." "A fringe or loose cartilage on the external aspect could be pushed into the joint, almost locking it completely." Flexion was possible to a right angle and extension was limited fifteen degrees. No x-ray was taken.

Discussion.—To begin with, we should state that this case differs from the average in that the onset was toxic instead of traumatic, the duration of the trouble before operation longer than is usual, and the joint pathology found at operation a good deal more extensive. The average findings are given under this heading in the section on surgical pathology.

The patient had developed a multiple arthritis of the "proliferative" or "infectious" type, six years previous to her entry and had sustained persistent disability to the internal structure of her right knee. She probably developed the trouble with the joints of her hand at the same time.

The discomfort in walking and the tiring easily point to a chronic inflammatory process of the soft or hard tissues, but the feeling of something slipping indicates an additional trouble—mechanical interference with joint motion. This symptom is of a mild nature and has never been accompanied by locking, thereby indicating a soft tissue rather than a hard tissue derangement. The mode of onset—a toxic arthritis—indicates pathology of the synovial villi rather than of the

infrapatellar fat-pad. (An acute toxic process is more apt to cause hypertrophy of the synovial villi than of the infrapatellar pad.)

A local examination is required, however, to decide whether fringes, fat, or both are involved. It shows a general thickening of the capsule, a condition seen in hypertrophic villi and not in an hypertrophic fat-pad. In addition, the "fringes could be palpated," a finding which was probably correct, in view of the operative findings. The motion was markedly limited, so much so that it should be attributed to a more extensive process than a mere hypertrophy of soft tissues. However, fringes usually give some limitation while a fat-pad gives very little. There was also considerable crepitus, which is more than we should expect from a fat-pad. Finally, inspection failed to reveal a feature seen at times in fat hypertrophy, a swelling on one or both sides of the patellar tendon.

We therefore place villous arthritis ahead of hypertrophic fat and come to the last question, the nature of the "fringe or loose cartilage" on the external aspect of the joint. The history and examination, except for this, point to a soft tissue rather than a cartilaginous derangement. Besides, it would be an unusual way for an external semilunar or a loose body to behave; the former is seldom palpable and the latter not so persistently palpable as this structure was. We therefore conclude that it is an hypertrophy of synovial tissue.

Operative findings showed a degenerated synovial membrane forming long, congested, thickened tongues, and exposing bare bone in many places. Many fringes and bits of loose tissue were removed.

The patient reported one year later that she doubted whether operation had helped her at all, and seven years later that the operation had been a great benefit.

Hypertrophic Arthritis.—A well-built colored man of 57 years, but not looking so old, a postal clerk by occupation, was admitted from the outpatient department in March, 1908, suffering from chronic pain on the inner aspect of the right knee.

Nine months previously, he had struck this portion of his knee against a mail truck and had suffered considerable pain at the time, but had had no swelling nor heat. He was treated in the outpatient department by adhesive strapping and plaster casts, but obtained only temporary relief therefrom. At the time of entry he was unable to stand at his work without suffering much pain, and had still more trouble on walking.

Examination.—His teeth were fair, his tongue fringed with several small, herpetic areas, his throat injected, and his tonsils not described. The abdomen was somewhat pendulous.

The right knee was normal in appearance, except for a slight prominence on the upper, inner border of the tibia. There was some tenderness in this area, but no heat. The motion of the joint was limited and painful on extreme flexion.

X-ray showed osseous projections from both the inner and anterior borders of the upper end of the tibia.

Discussion.—This case differs from the average hypertrophic arthritis in that it had a traumatic onset. In most of them, the cause of onset is unknown. This particular patient probably had an hypertrophic overgrowth at the time of injury, and suffered especially on this account.

The trouble was all localized at the inner aspect of the knee, where a bony prominence was found both on examination and by x-ray. The condition of the other joints was not stated. The pain was of a chronic nature, was made worse by prolonged use of the knee, and was never accompanied by locking. The story so far suggests chronic inflammation of tissues on the inner aspect of the knee, with no more disability than would be produced by pressing upon them in using the joint.

We look for a source of this inflammation and find it in the injury at onset, but cannot yet explain its persistence. On examination, we find a bony overgrowth over the upper, inner border of the tibia, with tenderness, and see by x-ray that this overgrowth is more extensive than is revealed by palpation. We feel a "creaking" sensation on moving the joint, indicating chronic involvement of the soft tissues.

Our findings so far are a tender, hypertrophic bony overgrowth on the inner aspect of the knee; hypertrophic bone elsewhere which cannot be palpated; and probably chronic irritation of the synovial membrane. We find no evidence of any tissue having been shifted from its normal place, for there has been no history of locking, nor of sudden attacks of pain with or without effusion, nor any fullness in the joint line. We therefore localize the trouble on the inner aspect of the joint and explain it by the bony overgrowth there, with the attendant changes in the soft tissues which we know must exist. The articular cartilage itself is insensitive, but the adjacent soft tissues are subject to pain.

Operation revealed a rough ledge of bone projecting from the antero-internal portion of the inner femoral condyle, and a bony spur on the tibia in a corresponding position.

As proof that these bony overgrowths were the source of symptoms,

it should be stated that the corresponding ledges on femur and tibia were removed, with resulting improvement for twelve years.

Summary of Signs and Symptoms.—The main features of the different types of cases will now be summarized, but there are many exceptions to the following statements, which in a summary are necessarily omitted. The most satisfactory method, probably, is to make a bald statement of the features as they appear in the average case and to leave the exceptions to be implied from the previous discussions.

Lateral Ligaments.—No case history of this type was cited, as the condition is not an internal derangement. It predisposes to semilunar injury, however, and is often associated with semilunar or crucial derangements. It must therefore receive a proper place in any general discussion of internal derangements.

The internal lateral ligament is much more frequently involved than the external. The mode of onset, signs and symptoms of the former condition are similar to those of a semilunar derangement occurring for the first time, except that the symptoms are not so severe, locking is absent, and tenderness is usually localized at the lower extremity of the ligament instead of over the anterior horn (Jones and Lovett). So the history begins with a severe, inward torsion of the knee, with sudden pain on the inside and often a sensation of something snapping. There is no locking, however, and the patient is able to walk, but with some difficulty. The pain is severe and persistent, and is usually followed by effusion.

Examination shows marked tenderness, usually at the tibial attachment of the ligament, increase in tenderness on attempted abduction of the knee, and often slight mobility in this direction. X-ray may show that a flake of bone has been torn away, thereby producing a sprain fracture. Instead of the tibial extremity, the femoral may be the portion affected.

The signs and symptoms of an external lateral ligament injury are similar to those of its mate, except that they are localized externally instead of internally.

Internal Semilunar Cartilage.—These cases have an average age of about 31 years, usually have a traumatic onset, always have pain and usually have locking with effusion. Their pain is confined to the inner portion of the knee and their lockings are rather serious occurrences, often with some difficulty in reduction. They have no limitation of

motion, unless the locking is continuous. Examination may or may not show effusion, but palpation of a case with recent locking often reveals two tender areas,—one in the joint line over the internal lateral ligament and the second over the anterior horn of the cartilage. X-ray examination is generally negative.

External Semilunar Cartilage.—These cases differ from the preceding type, in that they do not so often have a traumatic history, their symptoms in general are probably not so severe, and their pain and tenderness are on the outer aspect of the knee.

Crucial Ligaments.—The anterior is by far the more frequently involved. The patient has a history of severe trauma to the knee, and on examination of a recent injury shows swelling and ecchymosis. If the ligament is torn across, there is definite hypermobility in the antero-posterior direction, and the nature of this hypermobility shows which of the two ligaments is involved. Two other types of mobility of diagnostic value are internal rotation of tibia on femur, with the knee fully extended, and lateral rocking. Hyperabduction is usually present as well, from an injured internal lateral ligament. X-ray may or may not show a fracture of the tibial spine.

Tibial Spine.—There is a history of severe trauma, similar to that of a crucial case, and the crucial is often injured at the same time. Examination may reveal limited extension, and in this case the obstruction seems to be of a hard, bony nature. The internal semilunar may have been injured and may be the obstructing tissue instead, in which case the obstruction is of a less resistant nature. There may or may not be antero-posterior hypermobility, according to the condition of the crucial ligaments and their bony attachments. X-ray gives positive evidence.

Loose Bodies.—The average age is 38 years. The patient has often diagnosed the condition himself. He gives a traumatic history less often than do the internal semilunar cases but just about as frequently as do the external semilunar. There is usually a free interval between injury and onset of locking. The lockings are transitory and the pain accompanying them less severe than in semilunar derangements. The pain is often referred to different parts of the joint. X-ray usually gives positive evidence.

Hypertrophic Fringes.—These patients have an average age of about

33 years, give a traumatic history in about half the cases, and a history of arthritis due to infection, in a smaller percentage. They have had recurrent, sudden attacks of pain, but not of a severe nature, accompanied by effusion. They have not had severe attacks of locking, but may have had feelings of interference with joint motion, and in old cases, real locking.

Examination shows the knee slightly "full", and often with localized swelling on both sides of the patellar tendon. Palpation shows the joint capsule to be thickened and the localized swellings to be of a variable degree of resistance. There is slight tenderness on deep pressure, both over joint line and swellings. Motion of the joint produces crepitation and is a little limited. The quadriceps extensor shows some atrophy of disuse.

Hypertrophic Fat-pad.—The average age is 34 or 35 years. Over half the cases give a history of trauma or prolonged pressure. They have had transitory attacks of pain with effusion, like those of the villous cases. A dull ache is often present behind the patella (Jones and Lovett.) Examination often shows the swellings about the patellar tendon referred to above, and these swellings are slightly tender on deep pressure. They vary in degree of induration, on account of fibrotic changes. The knee does not look "full," except in certain cases of lipoma arborescens, and the capsule does not feel thickened. Joint motion reveals fine crepitation and is very slightly limited, if at all. Atrophy of the quadriceps is seen, as in the villous cases.

Hypertrophic Bone.—The average patient is over 50 years old, has no traumatic history and has had chronic pain, especially on use, for some time. He has also been troubled with limitation of motion and may or may not have had swelling. General examination often shows hypertrophic changes in the distal interphalangeal joints of the fingers or in other joints. Local examination shows bony overgrowth at the joint line, and there is apt to be tenderness in one or more of these areas. X-ray reveals more bony overgrowth than is evident on palpation.

Foreign Bodies (Jones).—This and the following three conditions will be taken up for the sake of differential diagnosis, as they may be confused with internal derangements. The foreign body most frequently found in the knee, in civilian life, is a needle, accidentally introduced in children or purposely in neurotic adults. It is apt to be a confusing case because of the bizarre nature of the symptoms. It may give remittent

effusion and locking, with very little local tenderness. The nature of the case is revealed by x-ray.

"Clicking" or "Trigger" Knee, (Jones and Lovett).—This is the condition in which a loud click is heard on acute flexion and sometimes on complete extension. If in extension, it occurs when the motion is all but complete and is accompanied by external rotation of the tibia. The causative findings so far have been obstructions associated with the anterior horn of the internal semilunar, and osteomata.

Osteomata (Alwyn Smith).—These growths often give rise to no symptoms at all. Those interfering with the inner or outer hamstrings are the ones which concern us most and are usually found just above the femoral condyles. The symptom most frequently complained of is a "slipping" at the back of the knee. Sometimes there is a complete locking, due to interference with the hamstrings. There is never any synovitis. The symptoms nearly always occur during active exercise. X-ray settles the diagnosis.

Simulation of Knee Derangement in Hysteria (Barker).—When such a knee is examined and motion attempted, the opposing muscles are felt to become tense and to resist. Etherization clinches the diagnosis. Barker tells of an interesting case in which he wanted to prove to the patient that she had no organic trouble with her knee. Without telling her what he proposed to do, he injected a spinal anaesthetic and then draped a sheet so that she could not see her knee. After the anaesthetic had taken effect, he began moving the knee and then had the sheet suddenly removed!

TREATMENT

The treatment of internal derangements aims at the correction of the deranged and injured condition of the tissues, accompanied by rest, so that the tissues may help to heal themselves. This correction is brought about by non-operative, operative, and medical means.

Lateral Ligaments.—The rupture of fibres of the internal lateral ligament is apt to cause a persistent laxity and sometimes to imperil the semilunar cartilage, unless the rupture is given ample opportunity to heal. The knee is therefore immobilized in a posterior wire splint or a plaster cast from hip to ankle, according to the severity of the rupture. Weight-bearing is allowed in from seven to ten days in the average case.

Immobilization for a period of four to six weeks is usually long enough. In addition, strain should be taken off the ligament by throwing the foot into varus, both by raising the inner portion of the sole and heel $^1/_4$ to $^3/_8$ of an inch, and by instructing the patient to walk with his feet turned straight ahead and his weight thrown on the outside. A ruptured external lateral ligament calls for the same treatment, except that the foot must be thrown into valgus and the patient instructed to throw his weight on the inner side of his foot.

A chronically stretched lateral ligament is treated by the varus position of the foot and a cage splint to prevent lateral motion, or by operation. One of these operations, devised by A. H. Edwards, reinforces the internal lateral ligament by means of tendon transplantation of the semitendinosus and gracilis. A second, devised by McMurray, shifts the lower portion of the sartorius forward to the bed of the lateral ligament, but without touching the insertion of the muscle. A third, devised by John Wilson, utilizes a band of fascia lata, which is cut from the internal aspect of the thigh, turned down upon the injured ligament, and sutured in place. In cutting the fascial band, the lower extremity is not divided. Edwards has also worked out an operation for the relaxed external ligament, by transplanting the biceps tendon and then laying a strip of the ilio-tibial band over it. Valuable details of fascial and tendinous transplantations have recently been published by Gallie and Le Mesurier.

Semilunar Cartilages.—A semilunar which has locked the knee for the first time should be reduced, if possible, and immobilized. The prescribed method of reduction is for the surgeon to flex the knee to the extreme, then to abduct the knee and get the patient to straighten it suddenly by a kick. Simultaneously with the kick, the surgeon aids in the extension and rotates the lower leg in a clockwise direction (Jones).

Assuming that the cartilage is an internal one and is obstructing by displacement centrally, either of the whole or a part, the mechanism may be explained as follows: Strong flexion brings the offending tissue into contact with the posterior portion of the internal condyle. Abduction produces a little space between tibia and femur internally, so that the obstruction has a clear path to slip outward. And sudden extension with clockwise rotation screws the tissue outward into its proper place. The sudden extension of the quadriceps, through the medium of the capsule, also tends to jerk the cartilage into its proper place. It should be noted here that the virtue of the sudden kick which so many patients use to reduce transitory lockings, probably lies in the sudden tension thrown

on the joint capsule, which in its turn jerks the cartilage outwards, even though the attachment between capsule and cartilage has been stretched or partially ruptured.

Complete reduction is, of course, an essential, and this condition is certain only when the patient can fully extend his knee actively (Jones). If the patient states that the knee still seems to be obstructed, he is probably right. Ether anaesthesia may make a reduction possible which cannot be obtained otherwise. Long duration of locking is not necessarily a preventive of reduction, and the procedure in such a knee should be the same as with one only a few hours old. It may be necessary to make a number of attempts before the operation is successful, and it may be of advantage to partially reverse the procedure in an obstinate knee, i.e., to rotate the lower leg in a counter-clockwise direction on sudden extension. The various positions assumed by a deranged cartilage explain the necessity for an occasionally modified procedure.

If reduction is accomplished, the knee is immobilized for six weeks. A plaster cast is the most satisfactory agent, but should be bivalved ten days after injury, so that massage can be begun. Weight-bearing is begun after three weeks or more. The patient is instructed to keep the foot turned straight ahead. In addition, his shoe is raised on the inside in order to aid in the production of the varus position. This position saves the internal lateral ligament until it has completely regained its tone.

If reduction is impossible, the cartilage must be removed. Furthermore, in those cases in which the symptoms of "slipping", "catching" or "locking" recur on slight provocation, we consider that the risk to the individual is less from a well-conceived and meticulously performed aseptic operation than from the injuries he is likely to receive from these sudden disablements. These disablements may take place at the exact moment when he is attempting to avoid a danger by a sudden movement, and may make the avoidance of this danger impossible.

We have followed in the main the technique of Sir Robert Jones, who sagely remarks that there is no margin for error in technique in operations on the knee-joint. The limb is shaved from mid-thigh to mid-calf at least 36 hours before the operation, carefully washed and scrubbed with gauze and sterile soap solution, ether, alcohol and biniodide of mercury, and a dry, sterile dressing applied which is retained by a bandage and adhesive plaster. Twelve hours before the operation the dressing is removed by a physician or nurse, whose hands have been scrubbed as for a surgical operation and who wears sterilized rubber gloves. The prepared area is again scrubbed with sterile soap and

water, ether and alcohol. A dry dressing is again applied and bandaged in place.

On the table, a tourniquet or Esmarch is applied. The prepared area is again scrubbed by the surgeon or his assistant after his own hands have been prepared for the operation and temporary sterile gloves put on. The whole limb is carefully draped so that it is free from other covering. Over the knee is placed a single layer of compress cloth wrung out in an antiseptic solution. No iodine is used. The knee hangs over the end of the table. The surgeon seats himself on a stool, with the heel of the bent leg resting on his own thigh, so that he may voluntarily slightly change the amount of flexion by moving his thigh. The incision is made through the compress cloth, which is later clipped to the edges. The line which we have usually employed is a three-inch (7 cm.) lateral and slightly "J"-shaped incision, starting opposite the middle of the patella, extending downward and curving rather sharply away from the mid-line of the limb for about one inch (2 cm.), just distal to the upper border of the tibia.

The knife used in making the skin incision is now discarded and the skin edges swabbed with alcohol. With a fresh knife the incision is continued through the lateral expansions of the vastus internus or externus, and the capsule and synovial membrane opened in this same line, but for only such a distance as is necessary to afford a satisfactory exposure. It will be found advantageous to first dissect away the coronary ligament from the portion of the cartilage which presents, in order to be able to grasp the cartilage firmly from above and below and thus ascertain by gentle traction the nature of the deformity. Careful dissection of the cartilage from its attachments is next carried out. By careful, gentle traction, almost the entire cartilage may be reached, a tenotome and small-jawed, blunt-pointed, long-shanked seissors being useful for this purpose. Under no circumstance should any injury to the lateral ligaments or crucials be done.

The joint is now inspected for tabs or other injuries, and the synovial membrane and capsule closed completely with fine, interrupted sutures. Our own practice has been to employ very fine black silk for this purpose, and we have had thus far no reason to regret the use of this non-irritating, completely sterilizable material. The lateral expansions are closed as the next layer in the same manner, and the skin as the third layer.

At no time during the operation does the operator's finger enter the wound. For any necessary sponging, swabs of sterile absorbent cotton wrung out (by instruments) in sterile salt solution are employed. The

sutures are handled and tied by instruments. Rarely is it necessary to tie any vessels. After the skin wound is closed, the knee is gently extended and a compression dressing applied. The tourniquet is removed and the knee placed on a soft pillow with firm sandbags on either side. Gentle active, painless motion in bed is not forbidden during convalescence, and the stitches are removed in seven days.

By ten days, active motion is encouraged and slight weight-bearing is allowed, if it is painless as it usually is. In two or three weeks, crutches or canes are abandoned and in a month the patient is allowed to resume his former activities.

Patients with recurrent lockings who refuse operation should be watched for the development of arthritic changes, which may become hypertrophic arthritis or tuberculosis (Jones). The non-operative treatment of cases with recurrent locking is a cage splint with a varus position of the foot (Jones and Lovett).

Crucial Ligaments and Tibial Spine.—Stretched or ruptured crucial ligaments are treated by prolonged immobilization, whether they are of recent or remote origin. In the latter case, enough benefit may be obtained to make a decided difference to the patient, and operation may be avoided. In the former case, the prognosis is much better still. If, in a recent injury, the knee is distended with blood, it should be aspirated; and the same applies to severe effusions of any other nature. Otherwise, the effusion tends to produce a general laxity of the ligaments.

The most satisfactory method of putting up the knee is in a plaster cast with the knee slightly flexed. The cast is bivalved—immediately in old cases and after two weeks in recent ones,—and the posterior half only is used. Massage is instituted early, after about ten days. Passive motion is begun after the knee has been immobilized for six weeks or longer and is followed by active motion. The stiffness resulting from the immobilization is found to be only temporary (Jones and Lovett). When walking is begun, the knee is protected by a cage splint for a variable length of time. It is allowed only 20 degrees of motion at first, with subsequent gradual increase in motion. Raising of the inner portion of the heel and sole is advisable in some cases.

If, at the end of the immobilization period, the symptoms of crucial derangement are still so marked as to interfere with function, operative correction may be tried. A fascial or tendinous substitution is made for the affected crucial and for the affected lateral ligament at the same time. This is the operation originated by Hey Groves and modified by Alwyn Smith. If the anterior crucial is involved, a strip of the ilo-

tibial band is run through tunnels in femur and tibia, following the course of the anterior crucial, and on its emergence from the tibial tunnel is drawn up and sutured to the femur near its internal tubercle, thus reinforcing the internal lateral ligament as well. If the posterior crucial is involved, the tendons of the gracilis and semitendinosus are divided and run through the joint in a manner similar to the above, but this time corresponding to the course of the posterior crucial as nearly as is practical.

In our own experience the above is a very considerable operative procedure and is rarely necessary if immobilization has been promptly employed.

Hey Groves believes that the best exposure of the operative field is obtained by means of a "U"-shaped incision, with the lowest portion of the curve below the tibial tubercle. The skin is reflected, the tibial tubercle with its insertion of the patellar tendon removed with a chisel, and the tendon and patella turned upwards. At the conclusion of the operation, the tubercle is fastened in place again by ivory or bone pegs. The knee is immobilized by a posterior splint after operation. Two or three weeks later, massage is begun. Six weeks after operation, the patient is allowed to be up in a light plaster. Finally, motion is allowed in a molded plaster cast with lateral hinges. This plaster is retained until all danger of lateral strain is past, three to six months after operation.

Fractures of the tibial spine, if they can be reduced and the joint fully extended, receive the same treatment as the non-operative crucial ligament cases (i.e., the knee is immobilized in a slightly flexed position). If extension cannot be obtained, the inflammation due to injury is allowed to quiet down and operation then performed. The knee is entered by the split-patellar route and the obstructing piece of bone removed. The post-operative care is the same as that of non-operative cases.

Loose Bodies.—If loose bodies are present and give rise to troublesome symptoms, they should be removed. Even if they produce only mild symptoms, they may be causing gradual arthritic changes and require removal for this reason. X-ray, symptoms, and signs are the criteria by which we decide the question of a progressive arthritic condition.

X-rays in both planes should be taken before operation, so that unsuspected bodies may be discovered. If possible, the body should be brought into a palpable position before anaesthesia, and held there until the operation is under way and the body can be transfixed or removed. If

the body is in the anterior compartment, the procedure to bring this about is to fully extend the knee and then "knead" it upwards, in the hope of pushing the body into the suprapatellar pouch. The knee is kept extended, if this manipulation proves successful, until the body is removed.

A body lying behind the anterior crucial ligament cannot be brought to light in this way, but flexion and torsion of the knee may dislodge it. One of the writers (Osgood) had a case a short time ago which showed one palpable body. The patient, however, stated that at times a second could be felt. The patient's story was believed and an experiment accordingly made on a cadaver to determine the probable location of the other body. Two soap balls were made, one about the size of the palpable body and the other somewhat smaller. Both were introduced into the knee joint of the cadaver through a split-patellar incision, and an attempt was made to "lose" them. It was always possible to bring the larger one into the suprapatellar pouch by extending and kneading the joint. The smaller was finally lost and on exploration of the joint was found behind the anterior crucial ligament.

At operation a few days later, the larger body was easily brought into the suprapatellar pouch and there removed by a small median incision. The operator remarked at this point that he would consider his work incomplete if he did not find the second body described by the patient. He therefore flexed the knee and rotated it. The second loose body then became palpable and was easily delivered from the suprapatellar wound. Thus the splitting of the patella was avoided.

If it is at all uncertain how many bodies are present, the split-patellar incision is the best for exploring the anterior chamber. The popliteal incision (Brackett and Osgood) is usually the best way to explore the posterior chamber. It is a longitudinal incision, just internal to the midline. The vessels and nerves are drawn to the outer side. Postero-lateral incisions have been proposed by Henderson for bodies located in those positions. Both postero-lateral incisions are made with the knee fully extended, the external just outside the biceps tendon and the internal just internal to the tendon of the semimembranosus. After the skin incision has been made, the knee is moderately flexed so as to draw the tendon out of the way and make the capsule readily accessible.

No post-operative immobilization is required unless the split-patellar incision is used. In that case, a plaster cast or posterior wire splint should be kept on for between two and three weeks, and massage of the muscles begun after ten days.

Local anaesthesia is a very satisfactory agent for removing a loose

body which can be easily located and lies free in the joint. McWhorter has even found it satisfactory in removing the semilunar cartilage. In the latter case, the anaesthetic is injected into the joint cavity, as well as into the tissues around the incision.

Hypertrophic Fringes and Fat.—The keynote of treatment in these cases is the protection of the hypertrophied tissue from internal trauma until it can atrophy to its normal size. After this stage is reached, it ceases to be traumatized internally and the condition is cured.

The type of protection employed varies according to the severity of the trouble. Strapping of the anterior aspect of the knee with adhesive tape is sufficient, in moderate cases, to withdraw the affected tissue from between the joint surfaces. A cage splint, with a stop preventing full extension, is necessary in the more severe ones (Jones and Lovett.) In the latter type, extension is limited about 20 degrees at the start, and this figure is gradually reduced as the symptoms improve. It may be necessary to keep the patient off his feet temporarily.

Exercise of the quadriceps extensor increases the pull of this muscle on the capsule during the process of extending the joint. This pull is transmitted to the fringes and fat-pad, as previously described. It is, therefore, a very definite aid in reducing internal trauma. The exercising should, of course, be done without weight-bearing, in order to avoid further injury to the tissues.

If the symptoms remain severe after a reasonable course of non-operative treatment, it is advisable to operate, but this is not often necessary. The incision usually made is just internal to the lower part of the patella, in the case of an hypertrophied infrapatellar pad, and the fatty mass freely excised. It may be necessary to make a similar external incision. No functional disability follows the removal of this tissue (Jones and Lovett).

Hypertrophied fringes are freely removed in a similar manner. The removal of a considerable portion of the synovial membrane with its dependant villi, constituting a synovial capsulectomy, has been revived lately and found to be desirable in certain cases. This type of operation is advocated by Skillern, and has been practised by Baldwin and Swett.

Hypertrophic Bone.—The method of attack in these cases is two-fold, freer elimination of injurious agents and the reduction of intra-articular friction.

Patients with this condition are apt to have a sluggish intestinal activity, which must be improved. Bodily mechanics are of primary import

ance in bringing this about—improvement in posture with a drawing in of the pendulous abdomen. The abdomen is first supported mechanically, and later by gradually-regained muscular activity.

A bulky diet will produce a more active peristaltic action. Reduction of food elements which putrify readily will reduce the amount of toxic material. Elimination of toxic agents is also sought by means of the urinary tract and the skin. The use of sodium phosphate has been found especially satisfactory because of its combined laxative and diuretic properties.

In addition, elimination of injurious agents at their destination, the joint, is aimed at. Heat, massage, and movement are employed for this purpose. Moist heat and diathermy seem to be the best types of heat to use. Their action is merely the improvement of circulation. Gentle massage and painless motion may serve the same end and, in addition, help to prevent atrophy. General building up of the powers of resistance is also sought by attention to the diet, by rest, and by baths.

The reduction of intra-articular friction is sought by means of adhesive plaster strapping, cage splint, Thomas caliper, leather support, plaster cast, traction in bed, or operation, according to the severity of the case. Operation is occasionally resorted to, in the form of joint excision, to produce ankylosis. This is the most satisfactory means of reducing joint friction in those cases whose only alternative is severe pain and disability. It may not be successful, however, as it leaves pathological bony surfaces in apposition, which may unite with difficulty. An alternative operation, joint erasure, leaves eburnated surfaces in apposition, which unite with much greater difficulty. Operation is much oftener required to remove bony overgrowths which interfere with the joint motion, press upon nerves, or are themselves subjected to painful pressure.

In concluding, stress should be laid on the value of team work between the physician and surgeon, both attacking the toxic element, and the latter looking after the mechanical as well.

PROGNOSIS

With the proper treatment, the general prognosis for recent internal derangements is good, but becomes less and less favorable the older the case before it receives treatment.

Lateral Ligaments.—A recently ruptured lateral ligament will probably heal entirely if protected from strain until it regains its tone. A

relaxed lateral ligament, of long-standing, may improve enough under immobilization to require no further treatment. If operated upon by one of the tendon or fascial transplant methods described, definite improvement may be expected, but often not a complete restoration of normal stability.

Semilunar Cartilages.—A recently deranged semilunar which has been completely reduced and immobilized may give no further trouble. A recent semilunar case which has been operated upon has an excellent prognosis. An old, recurrent semilunar case is usually much improved by operation, but the prognosis varies with the findings at operation. It is less favorable, the greater the arthritic changes. If definite hypertrophic changes are found, the prognosis may be favorably affected by improvement in the eliminative functions of the body. An unoperated, recurrent semilunar is always a care, both on account of the nuisance of wearing a brace and the danger of a recurrence.

Crucial Ligaments.—Recent crucial injuries with prolonged immobilization in good position give surprisingly good results. This means that operative treatment is usually unnecessary. In regard to the Hey Groves operation, we have not personally observed the end-result in any cases. Jones has observed definite improvement in some of them. Old, unoperated crucial cases showing a marked hypermobility, have often only a small amount of disability therefrom (Jones).

Tibial Spine.—Recent fractures of the tibial spine which have been reduced and immobilized will probably give very little trouble in future. If the fractured piece obstructs and is removed by operation shortly after injury, the prognosis is nearly as good. If the injury is accompanied by rupture of a crucial, the outlook is not so favorable. In old fractures of the tibial spine, the range of motion can often be improved and the pain and stiffness markedly lessened by operation.

Loose Bodies.—The prognosis depends on the nature of the loose body. If it is the result of an hypertrophic arthritis, this removal is only a palliative measure. Permanent improvement can be hoped for only if the progress of the disease is checked. If the body is the result of a flaking off of the articular surface, the prognosis is excellent unless it has set up chronic, progressive changes. If the body belongs to the third group—synovial chondromata,—its removal may effect a permanent cure. The prognosis is uncertain, however, because it is impos-

sible to tell whether the condition is progressive or will cease abruptly after operation.

Hypertrophic Fringes and Fat.—Those cases with a traumatic etiology can usually be caused to atrophy to such an extent, by strapping or immobilization, that they give no further trouble. The few cases requiring operation usually give very satisfactory results. If there is a toxic element present, however, the prognosis is less favorable. The operative findings indicate how severe the involvement is, but the outcome is, of course, mainly dependent upon the removal of the sources of intoxication.

Hypertrophic Bone.—It is still somewhat doubtful how much improvement is to be expected from investigation of foci. From local treatment, much may often be expected. The diminution of intra-articular friction causes an abrupt improvement in pain.

The removal of bony overgrowths, which are painful themselves or are causing pain or obstruction, gives definite relief, but no assurance can be given against their recurrence. In our experience, however, there has been no recurrence. The attempt to obtain a stiff joint by excision may not be successful. Joint erasure is even less apt to be successful.

REPORT OF CASES

We shall first review the method used in following up these cases, and then discuss the data obtained. To facilitate the reading of the report, we give the following summary:

A. Method
   - Circular Letters
   - Second Letters to Patients
   - Letters to Friends, Postmasters, Town Clerks, and Overseers of the Poor
   - Interviewing Local M. D.
   - Personal Follow-up
   - Data Already in Records

B. Data
   1. Statistics
      - Percentage of Total Number on Whom Reports Were Obtained
      - Frequency of Operation 1900-1910, Compared with 1910-1920
      - Frequency in the Two Sexes
      - Frequency of Each Type of Case
      - Average Age
   2. Preoperative Data
      - Pain, Locking, Limitation, Swelling, Hypermobility, Duration, Course and Onset, Nature of Onset, Cause of Onset

3. Operative Data
    - Incisions
    - Procedure in Various Groups of Cases, and Pathology Found
4. Postoperative Data
    - Convalescence Time
    - Signs and Symptoms
    - Patient's Point of View; Pain, Locking, Limitation, Swelling, Tiring Easily, and Hypermobility
    - Doctor's Point of View; Pain, Swelling, Bony Overgrowth, Limitation, Hypermobility, Roughness, and Atrophy
    - Results
        - General
            - Our Series
            - Comparison with Those of Others
        - Details of Results in Unusual Cases
            - Sepsis, Tuberculosis, Removal of Both Semilunars, and Ruptured Crucial Ligament
5. Conclusions

A. METHOD

The total number of internal derangements operated upon at the Massachusetts General Hospital between the years 1900 and 1920 was found to be 232. The total number of patients was 228, as several had more than one operation. Each of these patients was sent a circular letter inquiring in detail into the degree of relief obtained, whether the result was considered satisfactory and whether the patient would return to the hospital for examination. An additional question was added later, regarding the time of convalescence.

Only a small proportion answered these first letters, and this fact was explained in part by the long period, in some cases, that had elapsed since the patient had been discharged. Patients had changed their residence, and had not left their new addresses with the Post Office. On investigation, it was found that a number of patients who received the letter failed to reply through apathy. They reasoned that since they were cured, it was not worth while giving the matter a second thought, in spite of our urging them to report in the interests of science as well as self.

The idea might have been put in a clearer, more forceful way, but it is probable that human nature has not changed a great deal since the day long ago when ten lepers were healed and only one—a Samaritan—returned to report! Follow-up work in Samaria might be productive of more rapid results.

By intensive follow-up work—second letters and personal trips to various parts of the city and the suburbs—we were able to see many of these delinquents. In the large number of cases in which the letter was returned unopened, we attempted to follow-up by writing to a friend of the patient, obtaining the address from the hospital records. In certain cases, we also wrote to the local postmaster, the town clerk, or the overseer of the poor. In occasional cases, we interviewed the local M.D.

and found this method very satisfactory. As a last resort, we followed the patient personally from one address to another, and were often able to reach him. It consumed a great deal of time, however, and is of questionable value on this account. We obtained reports on a certain number from follow-up data which had been obtained by others and recorded in the records.

B. DATA

1. *Statistics.*—Reports were obtained on 177 patients out of the 228, or 77.5%. Two patients had had two operations each, and one, three, so that a report was obtained on 181 operations. Only these cases and operations will be considered. In the vast majority of the cases, the interval between operation and the obtaining of the report was two years or longer. In twelve cases, it was between one and two years; in six, it was between three months and one year.

In answer to the question whether the operation is being done more frequently than formerly, we found that—

49% of these cases were operated upon between 1900 and 1910.
51% " " " " " " " 1910 and 1920.

Of the total, 138 were males and 39 females.

The cases were classified under different diagnoses according to the operative findings. These findings were not always correct, as will be mentioned later.

78	operations were performed for	deranged internal semilunar	(43.1%.)
15	" " " "	" external "	(8.3%.)
41	" " " "	loose bodies	(22.7%.)
25	" " " "	hypertrophic fringes	(13.8%.)
9	" " " "	" fat	(5.0%.)
5	" " " "	" bone	(2.8%.)
3	" " " "	deranged crucials	(1.7%.)
3	" " " "	fibrous bands	(1.7%.)
2	" " " "	chronic arthritis	(1.1%.)

These conditions are all old friends—or rather enemies—of the surgeon, with the exception of "Fibrous Bands." Their nature will be described in the operative data.

The average age at operation was:

Semilunars	31 Yrs.	(Oldest, 64	—Youngest,	12)
Hypertrophic Fringes	33 "	(" 64	— "	21)
" Fat	31½ "	(" 56	— "	18)
" Bone	53 "	(" 73	— "	30)
Deranged Crucials	32 "	(" 36	— "	27)
Fibrous Bands	21 "	(" 41	— "	9)
Chronic Arthritis	36½ "	(" 43	— "	30)

Preoperative, Operative, and Postoperative Data.—Certain general aspects will be discussed. The pre- and postoperative data were not obtained from every patient. In those data obtained from so few cases

as to throw doubt upon their value, a statement is made to that effect. The "six larger groups" referred to in various places are the two semilunars, the loose body, and the three hypertrophic tissue groups. Only these groups are considered in the discussion unless special reference is made to others.

2. *Preoperative Symptoms.*—Pain is seen to be almost universally present throughout.

Locking was present, at one time or another, in all of the external semilunar cases, 82.4% of the loose body, and 79.5% of the internal semilunar. There is a marked hiatus in the frequency of locking between these groups taken together and the hypertrophic tissue groups:

Fat	55.5%
Bone	50.0%
Fringes	33.3%

In regard to the crucials, two of the three showed locking, but the third probably did not. The total number is so small, however, that these figures are worth little by themselves.

The question of preoperative locking brings up a valuable diagnostic point: A young man was admitted with the diagnosis of deranged internal semilunar. He stated that on the previous day he was kneeling to catch a ball when he felt something snap in his knee. On attempting to rise, he found that sudden weakness had developed in the knee, and that he was unable to rest any weight upon it. He was carried home. He came to the hospital the following day and was admitted at once.

According to the patient's statement, there had been no locking; physical examination also revealed none. The knee could not be straightened voluntarily, but the examining surgeon reported that it could be straightened passively. (There was probably failure on his part to distinguish between extension and hyperextension.)

Operation one week later revealed the anterior end of the internal semilunar dislocated and locking the joint.

The missing of this point before operation was of no consequence in this particular case, as the cartilage was removed, but it would be of marked importance in such a case if a non-operative procedure were employed. It would result in permanent obstruction to full extension, from the dislocated cartilage.

A story of prolonged flexure suggests a persistent locking. The question can be settled definitely by adopting voluntary, complete hyperextension as the criterion of complete reduction.

Limitation of Motion.—This refers to limitation exclusive of locking. These two types of interference were carefully distinguished. In limitation of motion, the hypertrophic trio heads the list:

Hypertrophic Bone	85.7%
" Fringes	56.5%
" Fat	44.5%

The semilunar and loose body groups all fall below these percentages:

External Semilunar	33.3%
Internal "	21.0%
Loose Bodies	18.4%

Swelling.—Five of the six larger groups had swelling as a symptom in over two-thirds of the cases:

Internal Semilunar	83.6%
Loose Bodies	75.7%
Hypertrophic Fat	75.0%
" Fringes	73.9%
External Semilunar	69.2%
Hypertrophic Bone	57.1%

It was a feature of all the crucial cases, as we should expect.

Hypermobility.—This symptom is headed by the group subject to the severest trauma—the crucials. The second place is occupied by the next most severely traumatized group—the internal semilunars:

Crucial Ligaments	66.7%
Internal Semilunars	11.1%
Loose Bodies	8.1%

The other four had no case showing this symptom. In regard to the external semilunar group, the implication may be that the agent causing this derangement is not so apt to injure the lateral ligament on that side as it is in the case of the internal cartilage.

In regard to the crucial group, the question arises why one of them failed to show hypermobility. This case had a ten-year duration of trouble, which resulted from stopping suddenly while running. The patient stated that the leg seemed to go out from under him simultaneously with the onset of sharp pain. He did not remember any torsion. Limitation of extension resulted, but its duration is not stated. There were many subsequent attacks, usually following a minor injury, always with limitation of extension and with sudden terminations. Examination showed a slightly recurved position of the knee, slight puffiness just external to the patellar tendon, and tenderness in this area. Extension was possible beyond a straight line, and flexion beyond a right angle. The unaffected knee was also recurved and had localized swelling external to the patellar tendon.

X-ray of the affected knee showed a slight tendency to hypertrophic changes, but nothing else.

We should have expected to find a deranged semilunar cartilage and an hypertrophied fat-pad at operation, and should not have expected to find a crucial involvement. The findings were a complete rupture of the anterior crucial ligament and an hypertrophied fat-pad.

It is impossible to reconcile these preoperative and operative data.

Duration of Present Illness Between Onset and Operation.—The duration of illness varied a great deal in all of the larger groups, but in the majority of cases it was under three years. We therefore group those under three years and those of three years or more separately; we also subdivide the latter group when indicated. The following table gives the average duration of present illness in those cases of less than three years' standing:

(1)

External Semilunars—Less than 3 yrs.—Average,	12.3 Mos.
Hypertrophic Fringes	10.8 "
Loose Bodies	8.8 "
Internal Semilunars	8.4 "
Hypertrophic Bone	8.3 "
" Fat	6.4 "

The second table gives the percentage of the total in each group, which had a duration of less than three years:

(2)

Loose Bodies	—Less than 3 yrs.—	56.1%
Hypertrophic Bone		60.0%
" Fringes		60.0%
Internal Semilunars		78.4%
External "		80.0%
Hypertrophic Fat		87.5%

If we consider the cases of less than three years' duration in each group, we find that the average duration is as given in Table (1). If we consider the numerical relation of these cases to the total in each group, we find that the percentage is as given in Table (2). There is a marked incompatibility in the two tables regarding the external semilunar, the hypertrophic bone, and the hypertrophic fringe groups. The external semilunar group is at the top in the first table, but next to the bottom in the second. Perhaps the symptoms in the external semilunar derangements were not severe enough to call imperatively for early relief, for although locking was present in 100%, yet swelling was experienced by only 69%,—the next to lowest of all the six groups. In regard to the low rank of this group in the second table, we may imagine that the symptoms, although not severe, were persistently recurrent and caused 80% of the patients to give up the fight before three years were up, and seek relief. The low rank of the hypertrophic bone group in the first table is probably a matter of chance. One of the three cases which made up this average had a duration of only one month, although giving a history of rheumatism for years. The discrepancy in the hypertrophic fringe group cannot be explained. Five of the fifteen cases of less than three years' standing had durations of five months or less, and they are responsible for bringing the average so low.

Course.—In the internal semilunar group, over half of the cases had progressive symptoms. In the other five groups, a still larger number were progressive—between 70% and 80%.

Cause of Onset.—This was unknown in only 11.7% of the internal semilunar group. It was unknown in the majority of hypertrophic bone cases. In the other four, it lay between 30% and 40%:

Hypertrophic Bone—Cause unknown	80.0%
External Semilunars	39.0%
Fringes	36.0%
Loose Bodies	34.2%
Hypertrophic Fat	33.3%
Internal Semilunars	11.7%

Nature of Onset.—Over 90% of both semilunar groups had a sudden onset. Another interesting point is that hypertrophic fat is apparently more apt to cause a sudden onset than are fringes. Hypertrophic bone produced no sudden onsets:

Internal Semilunars,	Sudden	onset	94.9%
External "	"	"	92.9%
Loose Bodies	"	"	80.0%
Hypertrophic Fat	"	"	77.8%
" Fringes	"	"	52.0%

(3.) *Operative Procedure; Incisions.*—The lateral approach, with the lower end of the incision often being continued horizontally for a short distance, was employed 158 times. It was used in combination with the popliteal in one of these cases. Mitchiner has found that it produces a localized anaesthesia in a large number of cases, and tenderness on kneeling in some. Our cases have not complained of these features, but have often had very slight tenderness over the scar.

The split-patellar incision was used in 21 cases of our series, and in only two of these is there any chance of its having caused symptoms. In one of these we should say it was probably not at fault, and in the other, that it was, perhaps, partly at fault. In looking for loose bodies, we believe the split-patellar incision to be the best, unless the bodies can be readily localized in parts of the joint requiring only a small incision. We have two cases in mind which were approached by the lateral incision. One showed a loose body palpable on examination, but failed to reveal it at operation. The other was considered to be a case of osteochondritis dissecans, and had a history of injury followed by a free interval, with subsequent recurrent locking and swelling. Exploration revealed only hypertrophic fringes, which were removed without benefit. A split-patellar incision would have offered a much better view of the joint, with the possibility of revealing loose bodies or other pathology.

Procedures in the Various Groups; Pathology Found.—Of all the 93 semilunar cases, there were only two in which nothing was done on

entering the joint. In both these, the cartilage seemed normal. Both patients had subsequent trouble, went to other doctors, and were cured. The one had the semilunar removed, the other does not state whether she had an operation or not. These cases bear out the wisdom of Sir Robert Jones's advice as to removing the cartilage even if it appears normal, providing the preoperative diagnosis seems definite.

At least one of the two patients just mentioned above had locking after the first operation. Six others of our postoperative semilunar cases complained of it. The following melancholy data of operative procedures explain the recurrence of locking in six of these seven cases:

(1) Nothing removed.
(2) Excision, fragment of cartilage anterior to semilunar.
(3) Excision, loose flap coming from semilunar.
(4) Excision, two torn pieces of semilunar.
(5) Partial excision and suture of semilunar.
(6) Excision, anterior third of semilunar.
(7) Excision, semilunar.

In the seventh case the locking did not recur until at least eight years after operation, thus probably exonerating the operative procedure from responsibility.

In the loose body group, there was only one case in which nothing was found to account for symptoms. This case unquestionably had a free body in the joint, as it was palpated on entrance. It must have become attached to the synovial membrane or become lodged in a recess of the joint after operation, as it never gave trouble afterwards.

One case in this group gave a very interesting pathological picture. The patient was a young man with a history of trauma to the knee. Six months previous to entry, he had stepped off the edge of a trench during a sham battle and had landed on the opposite slope with his right knee flexed to a right angle. In landing, he struck his knee against his rifle. He had severe pain as a result, and was unable to bend or straighten his knee completely. After a few minutes, however, he was able to get up and hobble to his tent. The following day, swelling and extreme tenderness developed.

He was sent to hospital, where he remained three months. The treatment consisted of massage and the application of liniments. He went back to his work as a scale maker, one month after discharge, in spite of the persistence of symptoms. Two months later he entered the Massachusetts General Hospital.

At operation, a defect was found in the femoral articular cartilage on the external aspect of the medial condyle, extending posteriorly to the attachment of the posterior crucial, which was slightly torn. The defect was lined by a smooth, fibrous coat, except at the anterior margin, where it was ragged. Upon retracting the ligamentum mucosum, two loose bodies were seen, one, 2x1 cm., in the midline and apparently attached by a tab of tissue to the posterior crucial ligament; the other, 1x1 cm., lying free in the lateral portion of the joint. Corresponding to the smaller

body was a defect on the internal aspect on the external condyle, slightly invading the attachment of the anterior crucial ligament, which, like the posterior, was slightly torn.

This description was written in 1916, six years before the theory was published by Fisher, that such a condition is due solely to sudden tension on the crucials.

In some of the hypertrophic tissue cases which had an unsatisfactory result, we reviewed the operative findings with the idea of seeing whether this prognosis could have been made at operation. Apparently it could not, as the joints varied a good deal in appearance. One, which showed only a slight villous hypertrophy, continued to give more and more trouble postoperatively, until the patient had two subsequent operations at another hospital, neither of which helped her. The patient was described as, "A fat woman, not of marked intelligence," and may have had abnormal internal glandular activity. Fisher believes we may find this internal glandular element to be a causative factor in some cases of hypertrophic arthritis. In the succeeding operations, this patient showed adhesions, but there is no mention of an hypertrophic arthritis, except a roughened area on the under surface of the patella. In contrast to this, another knee showed extensive pathology: "Hypertrophic synovial membrane hung in short, thick folds from the quadriceps pouch . . . there were velvety, granular thickenings on the lateral and inferior portions of the synovial sack." This case had a satisfactory result, although motion was limited.

The conclusion is, therefore, that the average case which gives an unsatisfactory result, does so because there is a progressive postoperative process. The possible traumatic source of this down-hill course has been removed by operation, and leaves the toxic element as the still-active agent. The logical procedure in such cases, therefore, is to remove all possible foci and to reduce joint friction, on the assumption that the tissues are still inflamed.

In the villous group, only one case is listed as having had nothing removed, but in a certain percentage of these cases, the amount of villous material removed was so small that the operations were little more than explorations. One case is listed as having had a free body removed, but the operator apparently considered the villous element to be so much more prominent that it was diagnosed villous arthritis.

In the hypertrophic bone group, one case had only fat and fringes removed. It was clearly a case of hypertrophic arthritis, but the soft tissues were the only obstructing elements that could be found.

In the cases of crucial injury, two had a suture of the whole ligament and one, a partial suture. Results in the cases of suture of the whole ligament were: one very satisfactory and the other poor. The latter did not have hypermobility after operation, but did have tenderness, bony overgrowth, and marked limitation of motion. With hypermobility ruled out as the probable cause of the unfavorable result, we look to the severity of the original injury as being the most likely explanation. In the light of our present knowledge, if the disability persisted in spite of usually successful conservative measures, the surgeon might well con-

sider a Hey Groves fascial or tendinous transplant, in preference to suture, because of the friable character of the torn ends.

In the cases of "Fibrous Bands," the operative pictures show a band or cord stretching partially across the joint, but in no constant position, and described in one case as an eighth or a quarter of an inch in diameter. The histories of two cases definitely indicated derangement; that of the third did not. The records of the first two state that the tissue was excised; that of the third makes no statement, but excision was probably done. Results in all three were very satisfactory.

One case was of interest from the diagnostic and pathological standpoints, but was not a real internal derangement and so was not included in the series. The operative finding was a fibrous tumor, extra-articular, but attached to the external semilunar cartilage. The history was that of a protracted disability of two years' duration. The trouble began as a small swelling on the outer side of the knee without a known cause, and was followed two months later by stiffness and swelling. These symptoms were recurrent and the swelling was probably persistent, although there is no definite statement about it.

An operation had been performed six months before entry, consisting of the curettage of a bursa or cyst at this point, but without relief from swelling.

The condition was evidently a cystic growth attached to the semilunar cartilage, with evacuation at the first operation and removal at the second. The patient made a very rapid recovery following the second operation and was entirely relieved. Phemister considers this condition a cystic degeneration, and finds it identical with "ganglia" of the wrist and other parts.

(4.) *Postoperative Data; Convalescence Time.*—We obtained this information from less than half of the total number of cases. The point was not suggested until we were partly through with the work. In averaging these figures, we omitted those in which the figure was so large that it was out of all proportion to the average case. We believe that the average thus obtained gives a more accurate idea of the time required for convalescence.

The average time for semilunars—three and four-fifths months—is several times the average for private practice—one month. It may be that the private case spends more time and effort in regaining strength and motion.

Considering the loose body group in two sub-groups, those diagnosed "osteochondritis dissecans" and those not so diagnosed, the convalescence time in the former was eight months and in the latter two and two-fifths months. The former is a comparatively small group, however, and brings the average for the whole fifteen cases only up to three months. This disparity may possibly be due to the degree of injury to the femoral articular surface. All of the five cases going to make up the eight months average show definite injury to the articular surface or "the condyle," by which the articular surface is probably meant.

In the hypertrophic fat cases, the time required, three and a quarter months, was only half that required in the hypertrophic fringe, six and two-fifths months. The information in the former group, however, was obtained from only two cases.

In the hypertrophic bone cases, the time was excessively long, but it would probably have been reduced if information had been obtained from all the cases in the group.

Postoperative Signs and Symptoms.—We shall now review the postoperative signs and symptoms, first from the patient's point of view, then from the doctor's:

Postoperative Pain.—This column shows a vast improvement over the preoperative pain, which was almost universally present at one time or another. A greater proportion of the semilunar cases were relieved than of any other type, and a good deal larger percentage of the external than the internal were free from all postoperative pain. In contrast, all the hypertrophic arthritis cases had some pain.

Postoperative Locking.—This symptom was wholly wiped out in all of the external semilunar, hypertrophic fringe, and hypertrophic fat cases. The result was not so favorable in the internal semilunar group, with seven cases out of seventy-eight showing postoperative locking. Six of these did not have enough of the cartilage excised. The details have been given under "Operative Procedure."

Two of the external semilunar cases probably illustrate the same point,—the value of taking out all of the cartilage that is accessible. These two cases feel a momentary "catch" on flexing the knee to a certain extent, and this catch is also palpable to the examiner. It feels as if cartilage were slipping over a ridge of cartilage, and is presumably due to the edge of the remaining fragment of semilunar.

Postoperative Limitation.—All groups were improved in regard to this symptom, with the exception of loose bodies. In this group, the percentage of cases affected was actually higher than before operation. Examination in detail of the group shows that the cases diagnosed osteochondritis dissecans supply five of the nine cases affected. There were only eleven cases in all with this diagnosis out of the forty-one cases in the group. The injured articular surface is perhaps the malignant feature, as may also have been the case in regard to convalescence.

Postoperative Swelling.—There was marked improvement in this symptom in all groups except that of the hypertrophic bone. Curiously enough, this group had the lowest percentage of all in preoperative swelling, but, retaining the same figure—57.1%—had the highest percentage after operation. Apparently, operation was not able to affect this group at all in regard to swelling.

Postoperative Tiring Easily.—Every group had a certain percentage of these cases, ranging from 20% in the internal semilunar to 85.7% in the hypertrophic arthritis.

Postoperative Hypermobility.—Only three of the groups had cases complaining of this symptom:

Hypertrophic Bone	20 %
Internal Semilunars	6.7%
Loose Bodies	6.3%

In discussing this symptom, the internal semilunar group interests us most, because of the production of hypermobility at time of injury in certain cases and its occasional production in the course of operation. Three of the four cases complained of preoperative hypermobility.* In the fourth case, the incision was an internal one, and may have partly divided the internal lateral ligament. The local M.D., however, who examined the case for us, could not find any abnormal movement. The results on all four of these cases were unsatisfactory, being considered only "Fair" by the patients. These results should probably be attributed to a loose internal lateral ligament in three cases, and to a deep sepsis with a question of joint involvement in the fourth.

Postoperative Signs and Symptoms from the Examining Doctor's Point of View.—The "Doctor" in most cases was one of the writers, but his colleagues examined some, and the local doctor, others. In certain symptoms, the percentage from the doctor's point of view is universally lower than from the patient's. This discrepancy is easily explained, inasmuch as the doctor saw the patient on only one occasion, while the patient was referring to his whole postoperative experience.

Postoperative Pain or Tenderness.—The semilunars and loose bodies were the best off in this respect, and the hypertrophic bone cases the worst.

Postoperative Enlargement or Swelling.—The hypertrophic bone cases were the only group seriously affected by this symptom.

Postoperative Bony Overgrowth.—All the groups showed a 33.3% involvement, or more, but the overgrowth was not apt to be a disabling one. For instance, of the five external semilunar cases, which had a certain degree of bony overgrowth, all had a very satisfactory result.

*The examination data are not very satisfactory. In regard to the case which did not complain of hypermobility before operation, there is no statement of the corresponding physical finding. In regard to the other three, one had no statement, one was found to have no hypermobility, and the third probably had hypermobility.

Postoperative Limitation.—Only those cases in which flexion to 90° was impossible or in which extension was limited over 5°, were included under this heading. The lowest percentage was in the semilunars—12.5%; the highest, in the hypertrophic bone—83.3%. In the other groups, it ranged between 30% and 43%. The limitation was seen not to bear a definite relation to the bony overgrowth.

Postoperative Hypermobility; (Lateral and Antero-Posterior).—Comparing these figures with those of hypermobility as complained of by the patient, we see that in five of the groups the examiners found it more frequently than the patient complained of it. In the sixth, the symptoms were neither complained of nor found in any case. Apparently, slight hypermobility is often not noticed by the patient. It was not above 15% in any group except that of hypertrophic bone.

Postoperative Roughness.—By this is meant a bony grating on motion, or a feeling as of soft tissues being interposed. The figures indicate that it bears a certain degree of relation to bony overgrowth and to limitation.

Postoperative Atrophy or Hypertrophy of the Affected Limb.—We considered only a difference in circumference of half an inch or more, in measuring the calves and thighs, as constituting an atrophy or hypertrophy. Assuming that in unoperated individuals, the percentage of right leg hypertrophies over the left is equal to that of left over right, we find that the internal semilunar cases do not show any postoperative atrophy, but that both the loose body and the fringe cases do. The figures in the other groups are not satisfactory for drawing conclusions, because of the small number of cases contributing to these data.

Results, General.—Under "Very Satisfactory," we group those cases which were able to return to their regular work, with no difficulty of any account, or with none whatever. Under "Good" we group those able to return to their regular work, but with a troublesome disability. Under "Fair," we group those which were not able to return to their regular work, but which were improved to some extent by operation. Under "Poor," we group those cases which received no benefit at all.

An objection to this scheme of classification is that certain knees underwent such extensive changes before coming to operation, that they could not possibly give a very satisfactory result. But a classification from the other point of view,—i.e., considering the possible operative improvement in each case,—would be still less clear.

In cases in which doctor and patient disagreed about the value of the result, the classification is made according to the doctor's decision, but directly beneath, in parenthesis, are placed two results side by side. The first shows the doctor's opinion; the second, the patient's. A number before the letters indicates the number of such cases. E.g., (2 P—F) means that in two cases, the doctor considered the result poor, while the

patient considered it fair. There were five such cases, and in all of them the patient considered the result more satisfactory than the examiner did. Our results in detail, follow:

Internal Semilunars	64	Cases	(83.1%)—Very Satisfactory.
	3	"	(3.9%)—Good.
	1	"	(1.3%)—Fair.
	9	"	(11.7%)—Poor.
			(3P-F)
External Semilunars	14	"	(100%)—V. S.
Loose Bodies	34	"	(82.9%)—V. S.
	4	"	(9.8%)—G.
	2	"	(4.9%)—F.
	1	"	(2.4%)—P.
Hypertrophic Fringes	12	"	(48.0%)—V. S.
	4	"	(16.0%)—G.
	1	"	(4.0%)—F.
	8	"	(32.0%)—P.
			(P—G)
			(P—F)
Hypertrophic Fat	5	"	(55.6%)—V. S.
	1	"	(11.1%)—G.
	2	"	(22.2%)—F.
	1	"	(11.1%)—P.
Hypertrophic Bone	0	"	(0.0%)—V. S.
	2	"	(40.0%)—G.
	0	"	(0.0%)—F.
	3	"	(60.0%)—P.
Deranged Crucials	2	"	(66.7%)—V. S.
	0	"	(0.0%)—G.
	0	"	(0.0%)—F.
	1	"	(33.3%)—P.
Fibrous Bands	3	"	(100%)—V. S.
Chronic Arthritis	1	"	(50.0%)—V. S.
	0	"	(0.0%)—G.
	0	"	(0.0%)—F.
	1	"	(50.0%)—P.

The external semilunars all had very satisfactory results except one, in which the result could not be ascertained, as the patient developed a fresh trouble after operation. Loose body cases gave the next most satisfactory result, closely followed by the internal semilunar. The results in the fringe and fat cases were not nearly so satisfactory, and in the hypertrophic bone there were no very satisfactory results.

It is interesting to compare results obtained by investigators of similar cases elsewhere:

D'Arcy Power, in a questionnaire which he sent to postoperative semilunar cases in 1911, asked the question, "Has there been any return of symptoms?" In 82% of the replies, the answer was "No." In Hen-

derson's series, published in 1917, the internal semilunars on which a report was obtained showed a cure in 68.2%. In Strahlman & White's series of internal and external semilunars, published in 1921, 86% were completely satisfied with the result of operation. Our series shows about the same figure,—85.7% of very satisfactory results. Mitchiner, in an inquiry which he made last year, found that 95.9% of the semilunar cases were able to go through their ordinary, every-day life without any trouble. Figures in his other types of cases are given below and are compared with ours. Mitchiner's figures represent the percentage of cases which had no trouble with the knee during their regular work. Ours represent similar cases, combined with cases troubled slightly in one way or another:

	Mitchiner	S. & O.
Loose Bodies	82.6%	82.9%
Hypertrophic Fringes	81.3%	48.0%
Crucial Ligaments	100.0%	66.7%

Details of Results in Unusual Cases; Sepsis.—There were four cases of superficial sepsis and two of deep sepsis in the series. Of the deep, one did not involve the joint, and it is a question whether the second did or not. In the latter case, the wound was opened five days after operation because of indications of sepsis, but the culture taken was negative and the drains inserted were removed permanently two days later. The former case got a very satisfactory result ultimately, but the convalescence time was eleven months. The latter obtained only a fair result, probably due to joint sepsis or to the secondary operation with the introduction of wicks for suspected sepsis.

Four of these cases had a one-day preparation, one probably had a one-day preparation, and the sixth case is doubtful regarding the preparation as there was no note about it.

Tuberculosis.—Three cases in the series turned out to be tuberculous. In one, a movable semilunar was excised. At a subsequent operation on the same case, thickened villi were excised, examination of which revealed tuberculosis. In the second case, hypertrophic villi were excised. Pathological examination revealed tuberculosis, the symptoms recurred, and the joint was excised three months after the first operation. In the third case, serous fluid was evacuated and the joint washed out. Later, a diagnosis of tuberculosis was made from the persistence and type of the symptoms.

Examination of the operative notes on those cases indicates that the correct diagnosis could not have been made by primary operative findings, but the histories in all three cases were a little suggestive. Graduated doses of tuberculin injected subcutaneously might have revealed the real nature of the trouble. The excision of specimens at operation is, of course, very valuable.

A troublesome knee of long standing, which has been subject to recurrent pain, tenderness, swelling, and effusion and which has caused some

atrophy of the leg, is a fit subject for investigation regarding tuberculosis.

Removal of Both Semilunar Cartilages.—Two cases had both cartilages removed. One of these complains of weakness and giving way of the knee and is obliged to keep it constantly bandaged. The alternative explanations seem to be, a general ligamentus relaxation and the fact that both cartilages were removed. Our information in regard to the second case is not detailed enough to throw light upon the problem.

Rupture of Crucial Ligament with Fracture of Tibial Spine.—This case illustrates the result of immobilization for only a short period.

A ham-splint was applied upon entry, but had been removed by the fifteenth day, and a Bender bandage substituted. The note made on this date also states that the patient was walking with difficulty. Massage had been begun on the eighth day.

The result was not very satisfactory. The patient worked for a month after discharge and was then obliged to stop on account of disability in the knee. She entered the hospital again, two years after the first entry, and was operated upon. A partial suture of the anterior crucial ligament was done.

The patient finally obtained a very satisfactory result, but would have had a prompter and better recovery if she had had prolonged immobilization on her first entry.

C. *Conclusions.*—We repeat the statement that references to the groups in general apply only to the six larger groups, unless otherwise stated.

Method.—Letters to the patient and various other individuals are the first line of offensive attack on the end-result problem. Personal follow-up is the second.

Data; Statistics.—A large percentage of postoperative cases can be followed up, even though they cover a twenty-year period.

In our series, the frequency of operated cases was only slightly greater between 1910 and 1920 than between 1900 and 1910.

Preoperative Data.—Locking is much more common in the semilunar and loose body groups than in the hypertrophic tissue groups.

Limitation of motion is more common in the hypertrophic tissue groups than in the other three.

Complete, active hyperextension is the only satisfactory criterion of complete reduction.

Swelling is a common complaint in all groups.

Hypermobility is complained of most frequently in the groups subjected to the severest trauma, with the exception of the external semilunar group. The implication may be that the external lateral ligament is not so prone to injury as the internal.

External semilunar injuries seem to be less troublesome to the patient than those of the internal semilunar.

In the majority of cases throughout, the symptoms are progressive.

Hypertrophic fat is apparently more apt to cause a sudden onset of symptoms than are hypertrophic fringes.

Operative Data.—If the knee is operated upon for a deranged semilunar, as much of the cartilage should be removed as possible, regardless of a normal appearance. The only exception to this rule occurs when sufficient pathology is found, exclusive of the cartilage, to account for the symptoms.

The lateral "J"-shaped incisions are, in our opinion, ordinarily preferable. The mid-patellar incision is preferable in loose body cases in which the bodies are in the anterior compartment, but are not readily accessible.

The space behind the anterior crucial ligament should be investigated if the presence of a body is suspected in addition to the one or ones already found.

Postoperative Data.—Many hypertrophic tissue cases that have a poor result are probably suffering from progressive local intoxication. Investigation in that direction and reduction of joint friction is indicated rather than subsequent operation.

The convalescence time of semilunar cases, and probably of internal derangements in general, is longer in a general hospital than in private practice.

All groups show a certain percentage of cases that tire easily. The lowest percentage in our series was in the semilunar group, with 20%.

Slight hypermobility is often not noticed by the patient. However, in those semilunar cases in which it is noticed, definite disability is apt to be an accompaniment.

A certain percentage of cases in all of the groups, and hypertrophic bone cases especially, show localized pain or tenderness on examination.

A third or more of the cases in each group show bony overgrowth about the knee, but the patients often are not aware of it.

There is some relation between the incidence of roughness and limitation, and between that of roughness and bony overgrowth, but little relation between the incidence of limitation and bony overgrowth.

In the loose body and hypertrophic fringe groups, at least, a certain percentage of cases show some atrophy of the affected leg.

In our series, external semilunar cases gave the most satisfactory results. Internal semilunar and loose body cases came next. Hypertrophic fringe and fat cases were not nearly so satisfactory as the three preceding. Hypertrophic bone cases gave no "Very Satisfactory" results.

The cases reported by Mitchiner from St. Thomas's Hospital, London, covering the period from 1911 to 1922, have given the most satisfactory semilunar results to date.

A two-day preparation for operation should be used as a prophylactic against sepsis.

Cases that are at all suggestive of tuberculosis should be investigated for this possibility.

Suggested Outline for Records of Internal Derangements of the Knee

1. Past History—Old injuries or inflammations.
2. Present Illness.
   - A. Complaint
     - Pain—Nature, location, and whether constant or remittent.
     - Locking—Whether momentary, repeated, or permanent; whether reduction is easy or difficult, and exact procedure in reduction.
     - Limitation—Distinguished carefully from permanent locking.
     - Swelling—Whether persistent or remittent and whether associated with other symptoms, such as locking.
     - Hypermobility—Distinguished carefully from instability.
   - B. Duration
   - C. Course
   - D. Onset
     - Cause—Whether due to torsion, trauma, some other mode of injury, or to infection. If due to torsion, whether lower leg was rotated clockwise or counter-clockwise.
     - Nature—Whether sudden, rapid or slow.
3. Physical Examination
   - A. Inspection—Including details of any abnormal appearance.
   - B. Palpation—Presence and location of tender point. Presence of fluid, thickened capsule or bony overgrowth. Consistency of swellings.
   - C. Joint Motion—Presence of hypermobility, locking, limitation or roughness of motion. If hypermobile, whether it is in the antero-posterior or the lateral direction. If in the antero-posterior direction, whether tibia can be displaced forwards or backwards on femur.
   - D. Mensuration—Of thigh, knee and calf,—both legs.
4. Operative Notes
   - A. Exact location of incision.
   - B. Appearance and amount of synovial fluid. Appearance of synovial membrane, semilunar cartilages, crucial ligaments and articular surface, especially that of femur.
5. Postoperative Notes
   - A. Nature and duration of immobilization, if any.
   - B. Number of days before starting massage.

C. Number of days before starting motion.
D. Number of days before starting weight-bearing.
E. Number of weeks before regaining full function.

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THE PERIOSTEAL BLOOD SUPPLY AND HEALING OF FRACTURES

Experimental Study

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The importance of the intraossal blood vessels in healing of fractures has been emphasized by many authors; but they have all ignored the blood supply of the periosteum. It was Lexer who first suggested the importance of the periosteal blood vessels in the normal healing of fractures.

When this study was begun our hypothesis was: If the periosteum is the foremost osteogenic factor in the regeneration of bone, the blood supply of the periosteum should be of the foremost importance in the normal healing of fractures. To prove this hypothesis we conducted two series of experiments. All experiments were done on adult dogs. The first series numbered nine experiments, which were done as follows: An incision about three inches long was made along the internal margin of the radius through the tissues covering the periosteum of the bone. Over an area of about six cm. we separated all the soft tissues surrounding the periosteum of the radius. Carefully, not denuding the bone of its periosteum, we produced a fracture by means of a Gigli saw. The bone was always fractured in the middle of the shaft of the radius or in some portion of the distal half. The wound was closed with cat gut and a cast applied. X-ray examinations were made 14, 21, 28, and 42 days after the fracture.

The second series consists of five experiments on five dogs. These experiments differed from those in the first series only in that the location of the fracture was in the distal portion of the proximal third of the radius where the nutrient artery enters the bone. To make a complete separation of the tissues from the periosteum in this place it was necessary to divide the nutrient artery just above its entrance into the bone. Thus the fracture was produced through the entrance of the nutrient artery.

Figs. 1 and 2 are diagrams which attempt to demonstrate the relation of the radius with its intact periosteum to the soft tissues before and after separation is made between the two.

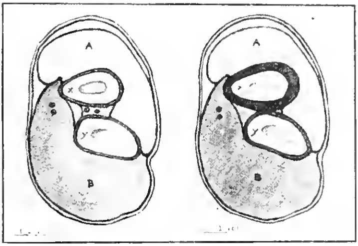

Fig. 1. Diagram of a cross section of the forearm of a dog slightly above the entrance of the nutrient artery into the radius. (a) Before separation of the soft tissues from the periosteum. (b) After separation of the soft tissues from the periosteum.

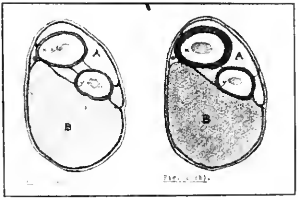

Fig. 2. Diagram of a cross section of the forearm of a dog between the third and fourth quarter. (a) Before separation of the soft tissues from the periosteum. (b) After separation of the soft tissues from the periosteum.

The results of the experiments of both series are shown in the reproductions of the X-ray plates accompanying this paper. Fig. 3 shows a control: a fracture of the radius was produced in an adult dog by the same method as in the series of experiments, except that the tissues covering the periosteum were not separated from it.

DISCUSSION.

We see from the figures that there was no union in any one of our experimental fractures. As we know, we may have non-union because of the lack of callus formation, or, even in the presence of callus we may have non-

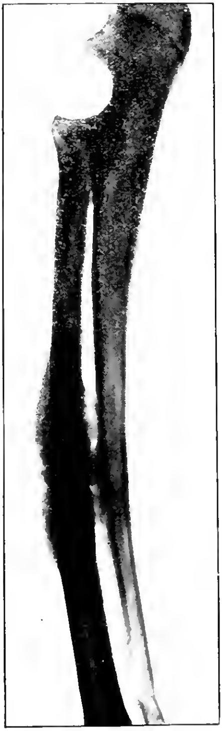

FIG. 3

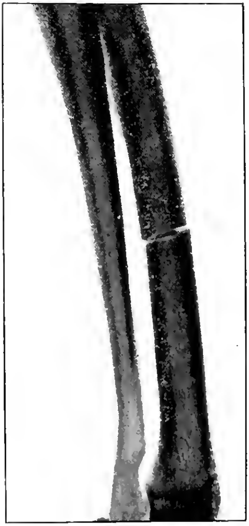

FIG. 4

Fig. 3. Normal adult dog. Open fracture of the radius without separation of the soft tissues from the periosteum. 42 days after fracture.

Fig. 4. Normal adult dog. Open fracture of the radius with separation of the soft tissues from the periosteum. 14 days after fracture.

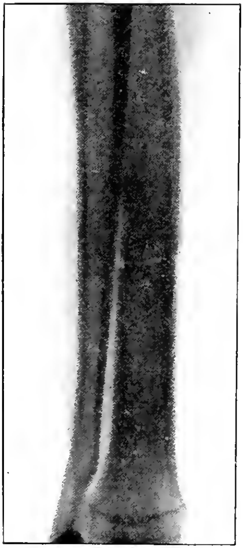

FIG 5

F.G. 6

Fig. 5. The same as fig. 4. 21 days after fracture.
Fig. 6. The same as fig. 4. 28 days after fracture.

union due to deficiency of ossification of the callus or to an early ingrowth of fibrous tissue between the bone ends. Disturbances of endocrine glands should be frequently considered as the etiologic factor in cases where there is lack of ossification of the callus. This I tried to point out in my paper, "Endocrine Disturbances and Non-Union of Fractures." In our experiments of the first series we have a marked exuberance of well ossified callus, but in spite of this no union has taken place. What then were the causes of this abnormality? The healing process in a fracture of a normal bone begins with periosteal callus formation. The endosteum is not able to participate in the callus formation until the intraossal blood circulation recovers by formation of an anastomosis between the central portion of the nutrient artery and the

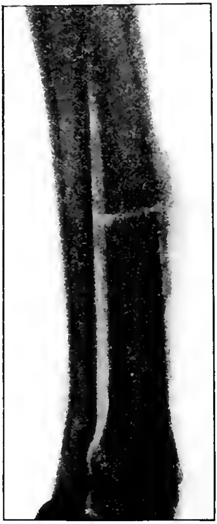

Fig. 7. The same as fig. 4. 42 days after fracture.

metaphyseal blood vessels. Only after this anastomosis has formed does the endosteum begin to produce endosteal callus. In our cases, in the first series, the periosteal blood vessels have been destroyed by the separation of the surrounding tissues from the periosteum. The periosteal osteogenesis could not take place until the blood supply of the periosteum had returned to normal. The endosteal osteogenesis, as is always the case in fractures, could not begin before the intraossal circulation recovered. In fact, fig. 4, 14 days after fracturing does not show as yet any evidence of callus formation. Profiting by these conditions, the always competing connective tissue grows into the vacant space between the bone ends and forms a fibrous septum. Later, when the periosteum recovers and begins to produce callus, this fibrous septum is in the way of the callus and leads to a partial absorption of the bone ends and finally to non-union and pseudoarthrosis. Figs. 6, 7, 9, 10, 11.

Fig. 8 is especially interesting. The dog in this case removed his cast on the first day after the fracture, pulled out the sutures, and opened the wound. Due to early measures there was no severe infection, and the wound

Fig. 8. Normal adult dog. Open fracture of the radius with separation of the soft tissues from the periosteum. 14 days after fracture.

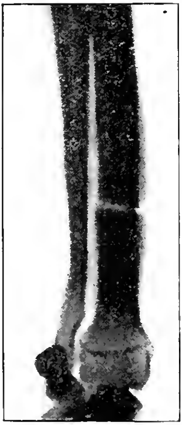

Fig. 9. The same as fig. 8. 21 days after fracture

Fig. 10. The same as fig. 8. 28 days after fracture.

11. The same as fig 8. 42 days after fracture.

soon began to granulate. This granulation process led to earlier recovery of the periosteal blood supply on the medial aspect of the radius—the seat of the wound. As a result of this recovery of the periosteal blood supply we see already on the 14th day after the fracture (Fig. 8) a distinct cloud of callus on the medial aspect, while on the lateral there is no evidence of callus formation. Figs. 10 and 11, showing this same case 28 and 42 days after fracture, demonstrate well the known fact that a slight infection of bone, as we had here, acts to increase the production of bone, while a severe infection checks it entirely.

In the second series, where the soft tissues were separated from the periosteum of the radius at the point of entrance of the nutrient artery so that both the periosteal blood vessels and the nutrient artery were destroyed,

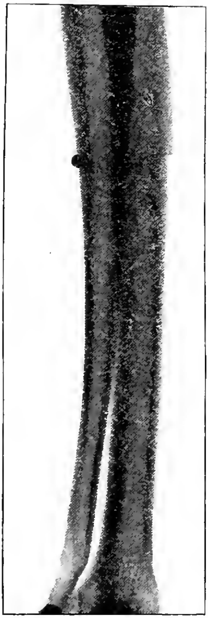

FIG. 12

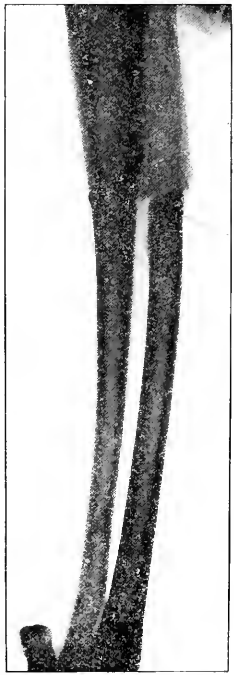

FIG. 13

Fig. 12. Normal adult dog. Open fracture of the radius with separation of the soft tissues from the periosteum and destruction of the nutrient artery. 21 days after fracture. The shot in the forearm was first revealed on X-ray examination.

Fig. 13. The same as fig. 12. 28 days after fracture.

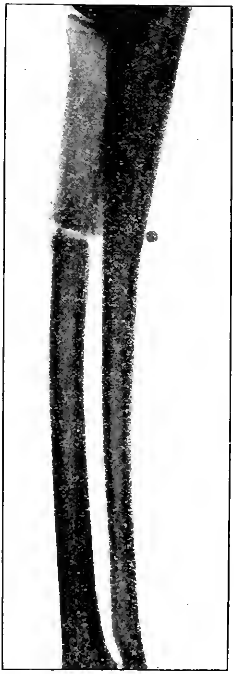

FIG. 14

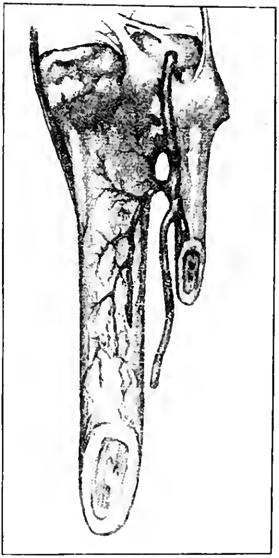

FIG. 15

Fig. 14. The same as fig. 12. 42 days after fracture.

Fig. 15. Drawing from a specimen. Showing the relationship between the nutrient artery of the human tibia and the periosteal blood vessels.

we have very scanty callus formation and non-union (See Figs. 12, 13, and 14). What were the etiologic factors of this deficiency of callus formation? In other words, to which of the destroyed blood vessels, periosteal or intraossal, should we ascribe this result?

It would seem that the importance of the destruction of the intraossal vessels as etiology of non-union has been overestimated by nearly all writers, because it is evident that in the normal healing of all complete fractures there is always a destruction of the intraossal vessels. To recapitulate: in normal fractures the periosteum, when normally supplied with blood, soon begins to produce callus. The endosteum begins to form endosteal callus only after the intraossal circulation recovers, due to formation of an anastomo-

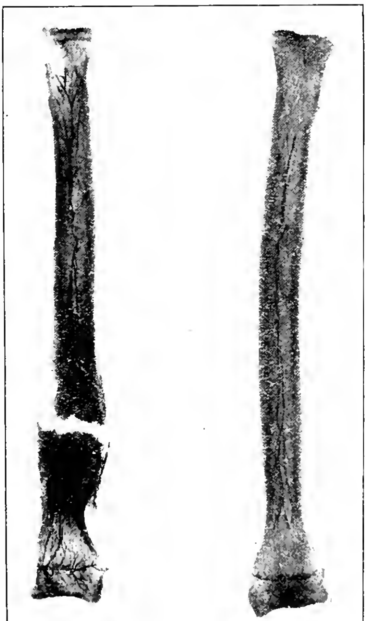

Fig. 16. Normal adult dog. Open fracture of the left radius with separation of the soft tissues from the periosteum. Blood vessels injected. 42 days after fracture. The normal right radius for comparison.

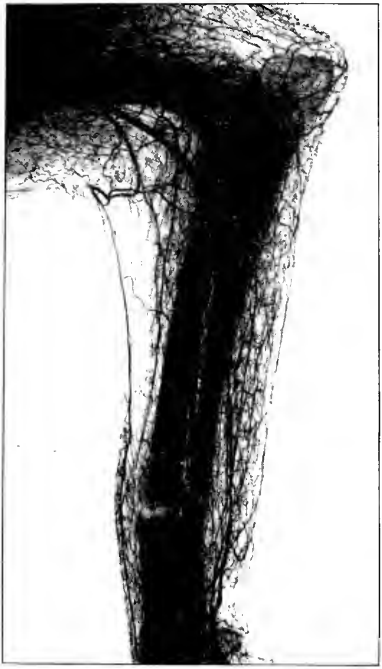

Fig. 17—a. Normal adult dog. Open fracture of the left radius with separation of the soft tissues from the periosteum. Blood vessels injected.

sis between the central portion of the torn branch of the nutrient artery and the metaphyseal net of vessels through the peripheral portion of the torn branch of the nutrient artery. In our experiments, where the nutrient artery was destroyed at its entrance into the bone, recovery of the intraossal circulation took place very slowly, only after formation of an anastomosis between the metaphyseal vessels of both ends of the bone. The separation of the soft tissues from the periosteum led to a marked impairment of the periosteal blood supply. The division of the nutrient artery completed the destruction

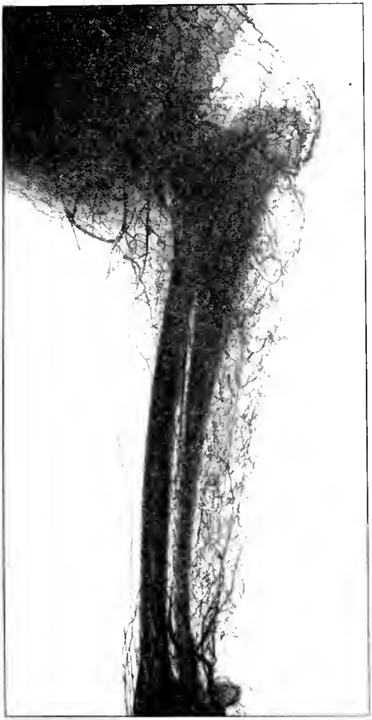

Fig. 17—b. The normal right forearm of the same dog for comparison. 42 days after fracture.

of the periosteal vessels in this area and increased the length of time necessary for the recovery of this circulation. But, before this slow recovery took place, the periosteum had passed from the stage of reactive stimulation into the normal stage of adult periosteum where osteogenic forces are latent. Because of this, when the periosteum finally recovered it was unable to produce callus. The endosteal callus could here have played a more or less useful rôle in the healing of the fracture if its blood vessels had not been destroyed and its

callus formation postponed for a very long period of time. We see from this that the destruction or ligation of the nutrient artery is important, in so far as the healing of fractures is concerned, only in cases where the periosteal blood vessels have been destroyed, and especially when the fracture is so located that the periosteum depends very largely for its blood supply upon the nutrient artery, as in our experiments of the second series. We are led to believe that this is also true in man. We have demonstrated from the study of the human tibia, which contains the largest nutrient artery of the human skeleton, that a limited area of the periosteum immediately about the entrance of the nutrient artery into the bone is dependent on that artery for its blood supply. A careful dissection of the leg, as shown in fig. 15, illustrates it very clearly.

Our experiments of both series prove that a destruction of the periosteal blood supply leads to non-union of fractures. That such a destruction is of frequent clinical occurrence is known to every one who has had the opportunity to observe a great many fractures associated with such crushing of the soft tissues as to separate them from the periosteum (leg run over by automobile; arm caught between belt and wheel, etc.) This, however, is not the only way in which the periosteal blood supply is destroyed. Rupture of the main vessels of the extremity by the bone fragments leads to hemorrhage and extensive thrombosis, and can bring about a disturbance of the periosteal circulation, which is sufficient to check, for a time, the callus formation, and so result in non-union. Further, contusion of the main vessel with rupture of the internal layer of the arterial tube, the external layer being intact, (a process which has been pointed out by H. Küttner*) also leads to thrombosis and to disturbances of the periosteal circulation.

We would like to touch briefly upon another point which we noticed during these experiments, viz., the changes of the blood vessels of the bone during the healing process. Healing of a fracture is always accompanied by an exuberant formation of the periosteal and intraossal blood vessels. This "fracture hyperæmia" in fractures of a forearm of an adult dog normally disappears about the 25th day after fracture. In our cases we still see the "fracture hyperæmia" after 42 days. Figs. 17a and 17b show a very pronounced new-growth of the blood vessels of the tissues about the fracture in comparison with the normal extremity. Fig. 16 shows the changes of the intraossal vessels, the branch of the nutrient artery, which supplied the

*Versammlung der Deutschen Gesellschaft für Chirurgie, 1921. Verhandlungen.

fractured portion of the bone having been replaced by a great number of anastomosing branches, while the branch in the uninjured portion of the bone has been markedly increased in size.

An analysis of the results of our experiments touches also upon an old disputed question—the supremacy of periosteal or endosteal callus. This question, which was solved at one time by the beautiful experiment of Ollier, has lately come into existence again. Lexer, who probably has done more work on regeneration of bone than anyone else, still holds that periosteal callus is far and incomparably more important than endosteal callus. On the other side, Bier's school claims supremacy for endosteal callus. Their basis for this contention is that grafted periosteum does not always give rise to new bone. The results of our experiments have convinced us that Lexer is right; the endosteal callus in our cases, of the first series, could not prevent pseudoarthrosis when periosteal callus formation was retarded. The claim that grafted periosteum does not always produce bone is unfounded because in the numerous experiments with periosteal grafts most authors did not distinguish between periosteum in stage of reactive stimulation for bone production and periosteum in the latent stage. Again, the age of the animal which supplied the periosteum for grafting was not taken into account. All these points are of the foremost importance. If we should express the difference between adult and young periosteum by an equation we would have: Periosteum of an adult animal plus reactive stimulation are equal to periosteum of a young animal. Reactive stimulations which are able to change the latent capacity for bone formation of the adult periosteum into an active stage are fractures, traumata, and slight infections of the bone.

CONCLUSION

1. An adequate blood supply of the periosteum is essential for normal union of fractures.

2. The periosteal callus plays a far greater rôle in union of fractures than the endosteal callus.

RELAXATION OF THE SHOULDER FOLLOWING BONY INJURY*

BY ROLAND HAMMOND, M. D., PROVIDENCE, R. I.

I wish to report three cases in which the capsule of the shoulder joint and the surrounding muscles have become greatly relaxed following fractures in this region. This condition was new to me until I discussed the subject with Dr. Frederic J. Cotton several months later and learned that he had recently written a paper upon the subject, which was published in the Boston Medical and Surgical Journal for October 6, 1921, Volume 185, page 405. I have encountered only those cases showing relaxation of the capsule and stretching of muscles with resultant subluxation and none of the cases of severer type in which a circumflex paralysis has been produced. The cases reported below are all fractures of the upper end of the humerus, in which the weight of the arm, swollen but not encumbered by apparatus, has produced a gradual exhaustion of the muscles of the shoulder, particularly the deltoid.

Case 1. The first case in which I observed this relaxation was in a fracture of the surgical neck of the right humerus with the fragments in good apposition. The fracture had been treated by a plaster swathe around the arm and chest, a triangular sling and some adhesive strapping over the shoulder. About ten days after the injury an x-ray examination was made to determine if the fragments were in good apposition before beginning manipulation. I was much surprised to note that the head of the humerus had dropped down and rested at the lower part of the glenoid. On examining the shoulder, I found that the head was actually lower than it had been when first seen following the accident and that a distinct groove or furrow was to be seen below the acromion. This relaxation could be easily overcome by lifting the arm upward so that quite a play in the joint capsule could be demonstrated. The shoulder could be moved up and down between one and two inches. At this time, I did not appreciate the significance of this relaxation and continued the treatment as outlined above. The shoulder recovered function well, and at the end of a month motion to a right angle was present. Ten days later, motions had recovered nearly to normal and weakness only remained. This patient was seen one year after the accident. No relaxation of the

*Read before the Boston Orthopaedic Club, February 26, 1923.

shoulder could be demonstrated either clinically or by x-ray. All motions were present except that abduction lacked about ten degrees of normal. All other motions were normal and the strength of the arm had completely returned.

Case 2. The next case was seen in consultation about the same time and was a fracture of the surgical neck of the right humerus. There was considerable swelling and ecchymosis about the shoulder, and x-ray examination showed the fragments in good apposition, but with so much subluxation of

Fig. 1. Case 1. Fracture of surgical neck of right humerus, taken a few hours after the accident.

the head that I feared there was a possible dislocation of the humerus downward. Accordingly, I gave the patient some gas oxygen and demonstrated that no dislocation was present. In this case, under anesthesia the humerus could be readily moved up and down to a distance of about two inches. The shoulder was tightly bound so as to overcome any further tendency to subluxation and the patient passed out of my observation. I did not see her for a year, when she returned at my request. Examination showed a normal shoulder except for some irregularity of outline of the bone at the site of

Fig. 2. Case I. Fracture of surgical neck of right humerus, taken ten days after accident, showing dropping of humerus from relaxation of shoulder.

fracture, but all motions were normal and the function of the joint had been completely restored.

Case 3. The third case was seen in consultation two weeks later with a fracture of the anatomical neck and also of the greater tuberosity of the left humerus. This injury had been received five weeks before and an x-ray examination at that time had been reported as showing the humerus in good position and the fragments in fairly good apposition. An x-ray examination five weeks after the accident had been reported as showing a dislocation of

Fig. 3. Case I. Fracture of surgical neck of right humerus, taken one year after accident, showing position of head in socket partially restored.

the humerus downwards. I was asked to see the case from the clinical aspect. Examination showed the head of the humerus apparently in its normal position in the glenoid cavity. All motions were limited, but could be carried out to a degree inconsistent with a true dislocation. There was no furrow nor sagging of the head which had been demonstrated in the other two cases. I made x-ray examinations both in the sitting and recumbent postures and found that the humerus was apparently dislocated downwards. There was, however, a small fragment of bone apparently displaced upwards from the

Fig. 4. Case II. Fracture of surgical neck of right humerus, taken two weeks after accident, showing subluxation of humerus.

head, which still remained in the joint cavity. With the clinical picture of a shoulder not dislocated and with the x-ray examination showing a small fragment of the head still remaining in the socket, I gave the opinion that no dislocation was present.

I did not see the patient again for one year. Examination showed the head in the same position in which I had found it one year before. There was considerable limitation of motion. Abduction and elevation could be carried out to nearly normal limits. Forward movements were practically normal.

Fig. 5. Case II. Fracture of surgical neck of right humerus, taken during anesthesia, showing how the relaxation could be relieved by forcing the humerus upward

but backward motion was so limited that the patient could not put the arm behind the body but only to the side of the hip. X-ray examination showed no change in the position of the bone from that found one year before.

These three cases have demonstrated that subluxation of the shoulder may exist without giving rise to symptoms and without apparent pressure on a nerve.

X-ray examination in the case of shoulder injuries may be a hindrance instead of a help unless the findings are checked up by a careful clinical examination.

Fig. 6. Case II. Fracture of surgical neck of right humerus, taken one year after accident, showing normal position of head in socket.

It is well known that the angle at which x-ray examinations of the shoulder are made will show the head in varying relation with the glenoid and the acromion, but never, so far as I am aware, to the extreme degree seen in these films.

Stereoscopic views may be of value in these cases. I wish to forestall criticism for not presenting stereoscopic films in these cases by stating that they were purposely omitted. In the third case, the diagnosis of dislocation was made by a rœntgenologist of wide experience on a flat plate, and I felt

Fig. 7. Case III. Fracture of anatomical neck and greater tuberosity of left humerus, taken five weeks after accident, showing subluxation of head of humerus.

that it would be better to carry out the examination in the other cases with flat plates and attempt to correlate the clinical and x-ray findings along these lines.

The subluxation, when of mild degree, takes care of itself and the shoulder recovers its normal function in the usual length of time.

With this tendency to relaxation of the capsule and resultant subluxation in mind, we should remember the possibility that this condition may follow any shoulder injury. It would seem to me that there is a possible danger in applying heavy apparatus to an arm to secure traction in a fracture of the shoulder joint, whether the traction be applied in bed or whether it be ambulatory.

Fig. 8. Case III. Fracture of anatomical neck and greater tuberosity of left humerus, taken one year later, showing subluxation persisting.

TREATMENT OF BONE AND JOINT TUBERCULOSIS WITH TUBERCULIN AND HELIOTHERAPY.

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In the last fifteen years there has been a tendency toward operative interference in tuberculosis of the bones and joints, due perhaps to the general trend of orthopaedic surgery during this time. The present trend may be considered as a wave which may have its recession but which will undoubtedly leave some well established methods.

It is the purpose of this study to emphasize the conservative and hygienic treatment without seeking in any way to detract from the importance of rational operative procedures. Although pulmonary tuberculosis has been treated by open air and sunshine methods for many years, we have more or less neglected these measures in the care of bone and joint tuberculosis.

Any effort which we may put forth in treatment must be regarded as an aid to nature, for it can not be said that the surgeon has a specific cure. He can only promote healing and preclude deformity. The healing process is an encapsulation by fibrosis, just as in pulmonary tuberculosis. There is a lack of accord among orthopaedic surgeons on many important methods, not to say principles. Part of this is due to interpretation of results in groups of cases, some of which may not have been tubercular. Prior to 1914, when we began to diagnose Legg-Perthes disease of the hip, all these cases were called tuberculosis and their incorporation in statistics renders conclusions as to averages unreliable.

Rest, heliotherapy, tuberculin and general hygiene are the methods of most importance in children.

TUBERCULIN.

Tuberculin has had its ups and downs perhaps more than any other one method of treatment. Its sponsors are in many instances no less radical than its condemners. It would appear that variations in results arise largely from variations in methods of administration. Waterhouse[1] who has a "profound faith" in it, uses Koch's New Tuberculin (TR) and begins every case with the minimum dose of 1/20000 milligram subcutaneously. He gives it once a week increasing the dose according to the following table:

1st week	1/20000 mg.
2nd "	1/15000 "
3rd "	1/12000 "
4th "	1/8000 "
5th "	1/6000 "
6th "	1/4000 "
7th "	1/3200 "
8th "	1/2400 "
9th "	1/1800 "
10th "	1/1500 "
11th "	1/1200 "
12th "	1/1000 "

If one dose causes marked reaction the next dose is not increased. The maximum dose is usually 1/1000 mg. He sometimes gives 1/250 mg., but never ventures beyond this.

Although tuberculin is practically harmless to a healthy person, it is a most powerful poison to a tubercular patient. Twinch[2] from an extensive experience, concludes that it is the "only known reliable remedy" for mesenteric and bronchial gland tuberculosis, which he regards as practically always the primary focus for tubercular joints. He reports 68% recoveries with it as against 34% without it. The average duration of cases which recovered under tuberculin was 11½ months, while cases without it averaged 5½ years. He regards it not as an extraneous protective but as a stimulant which causes the organism to make its own protective substance. Adequate time is required for this, so haste has no place in treatment with tuberculin. If temperature goes up one degree in second twelve hours, the dose is reduced after stopping entirely for one week. A positive reactionary phase must be maintained at a high level. A persistent or severe negative phase may be removed by hypodermic use of a nuclein, e.g., sodium tritico-nucleinate (0.001 once a week). He suggests that one of the favorable effects of tuberculin is the stimulation of leukocytosis which counteracts the leukopenia usually present in tuberculosis.

Pottenger[3] states that in 1905 he found a fourth of the institutions in Germany were using tuberculin, while on another visit in 1909 he noticed that it was being used in two thirds of them. His reports have to do mostly with pulmonary tuberculosis.

Kleinberg[4] comes out strongly against it. He reports thirteen cases extending over a period of two years and "can not recall a single case of out-and-out success." In only one case was there any improvement and, even in that, entire credit can not be given to tuberculin because autogenous vaccine was also used. Over confidence in it and improper dosage may result in exacerbations or even fatalities.

His results, however, are vigorously refuted by others, notably Landman[5] and Mayer[6]. The latter reports two cases of striking success and suggests that poor results may follow difficulties in administration. Landman refers to the files of Bonime's Polyclinic Tuberculin Dispensary for records of many cases in which good results were obtained. The conception of a cure at that dispensary includes complete tuberculin immunity, healing of blind pouches and sinuses, absence of recurrence over a period of two years during which the patient reports for observation every three months.

Bonime[7] observes the following principles: (1) A tolerance must be gained to the tuberculin to which the patient is hypersensitive. (2) A maximum immune response must be produced at each inoculation. (3) To get complete tolerance we must increase the dose each time sufficiently to offset the tolerance gained by the previous dose. (4) A constitutional reaction should occur at long intervals to give clue to dosage. (5) This reaction loses for the patient a certain amount of gained tolerance and increases his sensitiveness temporarily. A decrease in the next dose is required. (6) A local reaction does not call for decrease in the next dose.

Reliance can not be placed entirely on tuberculin as a specific, no more than on any other one method of treatment. It must be combined with rational hygienic treatment. Its administration to a patient confined to bed with a cast on in a more or less closed room, will give a result different from that obtained with the same dosage and same patient kept out in the open sunshine without casts. Individual variations in resistance and difference in hygienic environment are additonal factors to be taken into consideration in interpretation of results.

Before beginning the administration of tuberculin I make a Detré differential test to determine the specific susceptibility of the patient. The tuberculin to which the patient is most sensitive is then chosen for administration. The concentrated form is then diluted with normal salt solution to such a strength that the initial dose will require only about one-tenth cubic centimeter of the dilution. Two dilutions are usually sufficient to secure the proper strength.

For the cases reported here the bouillon filtrate (B.F.) was used, since all the patients reacted more sharply to this form than any of the others in the Detré test. The beginning dose was 1/20000 mg. injected subcutaneously. It will be noticed that the increase in dosage was practically the same for each case. This was due to the fact that there was practically no difference in their reaction to the tuberculin. The maximum dose of 0.01 mg. was reached after about three months' treatment. In the beginning the doses were given once a week and after a month increased in frequency

to twice a week. No constitutional reaction occurred which could be definitely attributed to the tuberculin. Although there was a rise in temperature in the first twelve hours following the dose in several instances, a similar rise was sometimes noticed with no relation to the time of the dose.

Two of these cases had secondary infections due to persistent sinuses, but they were not given vaccines because it was the aim to try the effect of tuberculin alone. Blood counts were made before beginning treatment and again after three months. The general appearance of the patient and of the sinuses were taken as additional criteria of effect of the tuberculin. The temperature charts (impracticable to reproduce here because of their length) were kept with records twice a day and every four hours for the first twenty-four hours following each injection.

No change was made in any other treatment when the course of tuberculin was begun. The children kept their same places on the sun porch and received their heliotherapy the same as usual.

Case 1. C. J. Girl, age 11. Tubercular spine. The disease began when she was about a year old and is said to have followed an injury in which her spine was thought to have been broken.

Admitted to Los Angeles County Hospital in July, 1919. Previous to this (date uncertain) she had had a spinal graft (Albee) operation, following which two sinuses appeared as described below.

Condition in September, 1922: General condition and nourishment good. Moderate kyphosis in upper lumbar region. Two sinuses, one about 20 cm. to right and the other about 20 cm. to left of the kyphosis. Abundant sero-purulent discharge from the one on the right, moderate amount from the left, requiring daily dressing.

Roentgenogram shows destructive process involving the third and fourth lumbar, the third almost totally destroyed.

Blood count: Hb. 35%. Reds 2,860,000. Whites 5200.

Detré differential tuberculin reaction: 0—0—4—0—0. 36 hours.

Patient on Bradford frame usually in ventral position with chest and shoulders supported producing hyperextension of the spine (Rollier position). Heliotherapy averaging about three hours daily.

Tuberculin, B. F., first dose October 2, 1922, 1/20000 mg., subcutaneous; once a week until October 30, then twice a week. Dosage gradually increased until January 4, when she was getting 0.01 mg., which was continued until January 15. No constitutional reaction. Local reaction six times.

SUMMARY OF TEMPERATURE CHART:

	99 to 100	100 to 101	101 to 102	102 to 103	103 or over
July	31 times	17 times	once		
August	34 "	19 "	4 times		
September	29 "	17 "	7 "	once	once
October	20 "	6 "			
November	24 "	6 "			
December	25 "	9 "			

The temperature was lower and more regular during the course of tuberculin. Conditions after 3½ months treatment: General condition appears about the same. No change noticeable in sinuses. Blood count: Leucocytes 7500.

Case 2. M.S. Boy, age 9. Tubercular spine. Nothing of significance in the family history. Had an abscess in the right groin for six years. This healed about a year ago but another one appeared in the left groin soon after.

Figure 1. Case 2. Tuberculosis of spine with complete destruction of I, II, and III L.

General condition (September, 1922) rather poor, pale and undernourished. Phlyctenular keratitis left eye. Tonsils small but cystic. Cervical glands small and soft. Chest: Tendency toward emphysematous shape due to kyphosis. Lungs: Scattered crepitant râles, increased whisper over right apex. Heart normal. Reflexes normal.

Moderate kyphosis upper lumbar. Five sinuses discharging sero-purulent material: one in lumbar region, one left inguinal, two in right gluteal region, one on posterior aspect of right thigh, upper third.

Roentgenogram (Figure 1) shows complete destruction of I, II and III L; partial destruction of XII D and IV L. Proliferation slight. Hips normal. Lungs: no conclusive evidence of tuberculosis.

Blood count: Hb. 55%. Reds, 3,880,000. Whites 11,200.

Urine analysis: Tr. albumen.

Cultures from sinuses gave growth of staphylococcus albus, hemolytic streptococcus and B. proteus vulgaris.

Detré reaction: 1—0—3—0—0.

Recumbent on Bradford frame since August, 1921; ventral and dorsal position alternately. Sinuses require daily dressing. Taylor tidal irrigation tried on two of them without permanent improvement. Heliotherapy about three hours daily.

Tuberculin, B. F. begun September 23 with 1/20000 mg. Given once a week until October 30, then twice a week. Dose gradually increased to 0.01 mg. beginning January 4 and kept at this amount until January 15. No general reaction. Local reaction three times.

	99 to 100	100 to 101	101 or over
July	22 times	10 times	
August	46 "	29 "	15 times
September	30 "	10 "	twice
October	19 "	8 "	
November	10 "	3 "	twice
December	22 "	9 "	3 times

Condition after 3½ months treatment: General condition improved; color better and face fuller. No appreciable change in sinuses. Blood count: Leucocytes 23000.

Case 3. R.A. Girl, age 7. Tubercular hip. Pain in right hip began in May, 1921. Admitted in May, 1922. Family history negative for tuberculosis.

Condition on admission: Eyes, mouth, throat, lungs and heart negative. Abdomen protruberant. Right hip flexed and adducted, painful and tender. Two small sinuses, one near the labia and one on outer side of upper right thigh. Discharge slight. Angle of adduction deformity 160 degrees.

Flexion deformity corrected by extension, but adduction persists. Roentgenogram shows advanced destruction of right acetabulum and of head and neck of femur (Figure 2). Marked destruction of XII D vertebra and partial destruction of XI D and I L.

Blood count: Hb. 65%. Reds 3,120,000. Whites 12,000.

Detré reaction: 3—0—4—0—0, 36 hours.

Patient has been kept in dorsal recumbent position on Bradford frame with extension and spica casts alternately on right leg. Helictherapy averaging about three hours daily.

Tuberculin, B.F. injections begun September 30, 1922, 1/20000 mg. once a week for four weeks then twice a week. Dose increased gradually up to 0.01 mg.

Figure 2. Case 3. Advanced tuberculosis of right hip with adduction deformity.

	99 to 100	100 to 101	101 to 102	102 to 103	103 or over
July	5 times				
August	3 "				
September	14 times	4 times	twice		once
October	7 "				
November	10 "	3 "			
December	8 "	once			

Condition after $3\frac{1}{2}$ months' treatment: No appreciable change in general condition. Sinuses are discharging much less than before treatment.

Blood count: Leucocytes 12,000.

Only cases with sinuses were selected for tuberculin treatment.

In Case 1, the temperature chart showed a striking regularity at a comparatively low level under tuberculin.

In Cases 2 and 3 the curve was also lower and more regular during the course of tuberculin, but not so noticeably so as in Case 1.

HELIOTHERAPY

Treatment of human ills by the sun's rays is not a new idea. It is said to have been used in the time of Hippocrates. The method is empirical, although theories regarding the therapeutically active part of the solar spectrum have been generally accepted. It is possible that the effect of roentgen rays, of artificial ultra-violet light and of direct sunlight may be due to the same order of vibration. The sun furnishes (1) actinic or chemical rays (wave length less than 0.39 microns), (2) light or visible rays (length 0.39 to 0.8 microns) and (3) heat rays (length 0.8 to 20 microns). All these rays are capable of being transformed into heat.

The rate of vibration varies inversely with the wave length. Thus, the visible or light rays vibrate at 430 trillion (wave length 0.8 microns) to 750 trillion (0.39 microns) per second. The earth's atmosphere transmits rays a little higher in frequency than this 750 trillion but there comes a point in the spectrum, at 0.29 microns wave length, above which transmission is not possible. The atmosphere is opaque to these rays. There is quite an appreciable difference in transparency of substances which we are accustomed to consider equally transparent. For example, ordinary glass transmits only those rays whose wave lengths are between 0.35 microns and 2.5 microns. It is, therefore, opaque to most of the ultra-violet and infra-red rays. The following table shows the relative transparency of various substances:

LENGTH OF WAVES TRANSMITTED

Glass	0.35	to	2.5 microns
Quartz	0.20	to	4.0 microns
Fluorite	ultra-violet	to	7.0 microns
Rock salt	ultra-violet	to	17.0 microns

Since ordinary glass is opaque to the rays of short wave length it is readily seen that heliotherapy can not be effectively carried out in glass enclosures or where the sun's rays pass through windows.

Pigmentation is a criterion of therapeutic effect. Patients who do not tan well do not derive as much benefit from heliotherapy as those who do. Blondes do not tan as well as those of darker complexion. Campbell says that negroes take on this pigmentation to such an extent that even the blackest of them can be made a shade blacker. On my visit to Rollier's hospitals at Leysin in 1916, I was surprised at the deep tan which he was getting on his patients. The skin resembled a well browned bread crust and seemed tough and resistant. I have never seen so deep a tan anywhere, even on the life guards at the beaches. Whether or not the rays penetrate actually to the joint does not seem to matter since the uniform pigmentation of the entire skin produces the desired result.

The local application of the rays is a method of necessity rather than choice but has a beneficial effect, nevertheless, on open tuberculosis and other chronic sinuses. One effective method of giving local heliotherapy is by means of the Thezac-Porsmeur lens. This is a 12-inch double convex lens with 72-inch focal distance. The effect is that of a burning glass and it is possible that the results are due more to a baking process than to the actinic rays which are mostly cut off by the glass. The lens is used at such a distance from the skin that the circle of light is from three to five inches in diameter. The method originated at Porsmeur in France and has been used by Lovett[8] from whose paper these details were obtained. Treatments are given beginning with five minutes a day, gradually increasing up to about half an hour. He reports marked improvement in a tubercular hip with sinuses, but unsatisfactory results in two cases of Pott's diesease with abscesses. Very pronounced improvement occurred in several cases of chronic non-tubercular bone diseases.

General heliotherapy, as introduced by Rollier, is the method of choice. Some difference of opinion persists regarding the most favorable locations for giving this treatment. Perhaps, as Lucas suggests, these opinions are influenced by the residence of the observer. Those who have institutions at the sea level claim that the best results are obtained there, while those who give the treatment at high altitudes claim that as the most favorable place. Data furnished me by the Mount Wilson Solar Observatory show a marked difference in atmospheric transmission between sea level and high elevations. This difference is greater for the shorter wave lengths than for the longer ones. It is also greater when the sun is inclined than it is at the noon

meridian. For instance, taking the wave length 0.4 micron in the following table, 73.8% of these waves are transmitted to Mt. Wilson and 53.5% to Washington at noon. When the sun is inclined 60 degrees, however, 53% are transmitted to Mt. Wilson and only 28.6% to Washington. In the former case the Washington (practically sea level) transmission is over 2/3 that of Mt. Wilson while in the latter case it is only a little more than one-half.

COMPARATIVE ATMOSPHERIC TRANSMISSION:

	Wave length	0.3 micron	0.4 micron	0.5 micron	0.6 micron	0.7 micron
		ZENITH DISTANCE 0°				
Mt. Whitney	14,500 ft.	50%	78.7%	90.5%	92.3%	95.4%
Mt. Wilson	5,500 ft.	31	73.8	87.3	89.6	95.2
Washington	Sea level	?	53.5	70.4	75.9	83.8
		ZENITH DISTANCE 60°				
Mt. Whitney		25%	61.9%	81.5%	85.2%	91.0%
Mt. Wilson		?	53.0	76.2	80.3	90.6
Washington		?	28.6	49.6	57.6	70.2

Since there is a much higher percentage of the various rays, especially the therapeutically active rays of short wave length, transmitted at high elevations than at the sea level it would naturally follow that the former locations are best. Furthermore, the longer wave lengths which produce the burning and depressing effects due to heat are not increased with high altitudes in the same proportion as the actinic rays.

With the idea of comparing the chemical effect of the sun's rays at different altitudes, and at the same time testing the amount of penetration, if any, through living tissues, I did a series of experiments with photographic paper. These experiments were all done within a period of three weeks in September so that variation due to seasonal height of the sun could not enter as a factor. Variations in atmospheric conditions due to moisture or other sources of haziness were practically eliminated because at this season of the year in southern California there is no appreciable difference in the sun's power from day to day. The old style solio printing-out paper was used in order to avoid variations in development which would occur with the bromide papers now in general use.

Exposures were made on Mount Wilson, elevation 5,500 feet, on the beach, and at an intermediate level of about 1,000 feet. All experiments were done as near noon as possible. Some were made as late as 2.30 but in comparing results, only those exposures made within a half hour of the same time of day were compared.

The exposed papers, after fixing, were measured on a scale. This scale

was made by exposing the same kind of paper on which the experiments were made for definitely timed periods of 5, 10, 15, 20 seconds, etc., up to 105 seconds and the 21 shades thus obtained were labeled 5 to 105 each one 5 points from the preceding one. These papers were then pasted on a card and a hole punched through the center of each. A graded scale analogous to the familiar hemoglobin scale was thus obtained.

Comparing the exposures made on Coronado Beach with those made on Mount Wilson it was found that there was a slight difference in the shade of the papers exposed for five seconds at the same time of day. The Mount Wilson exposures corresponded to shade 15 on the scale and the beach exposures to 10, the former one shade darker than the latter. For the longer exposure periods, however (10 to 60 seconds), there was no appreciable difference. No difference could be noticed between the Coronado and Pasadena exposures of any periods.

To test the penetration of rays through living tissue the palm of the hand was placed over the printing frame in such a way that any light which struck the paper would have to pass through the hand. At Coronado an exposure of 5 minutes through the hand produced no effect on the paper. Exposures of 15 minutes and 30 minutes produced a barely preceptible darkening, not enough to measure on the scale. The Pasadena exposures of 5 minutes through the hand gave a very slight darkening and those of 15 minutes produced a shade a trifle lighter than 5 on the scale. Exposures on Mount Wilson through the hand gave distinctly darker shades than those of Coronado or Pasadena. The 15 minute exposure was slightly lighter than 10 on the scale and the 30 minute exposure corresponded fully to 10. For finer comparison the short exposures were best. The exposures of 60 seconds were so dark that readings on the scale were not as easy as those of 5 to 30 seconds. One interesting observation was that a difference in time of day easily cancels any difference that may be due to altitude. For instance, at noon exposure on the beach of 60 seconds gave shades corresponding to 95 and 100 on the scale, while exposures at 2.30 on Mount Wilson corresponded to 75.

Further experiments along this line are necessary before drawing broad conclusions, but the foregoing results show that there is greater penetrating power at the higher elevations. This penetration may be due to the greater abundance of high frequency rays at higher altitudes.

That light has a destructive effect on the tubercle bacillus is a fact well known to bacteriologists. According to McFarland[9], the organism does not develop well in the light and when its virulence is to be maintained the culture must always be kept in the dark. Direct sunlight kills it in from

a few minutes to several hours depending on the thickness of the mass of bacteria exposed. Park and Williams[10] found that sputum containing the organisms when expectorated on the sidewalk in direct sunlight is sterilized by the time it is dried sufficiently to be blown away in the dust. Moody[11] says that cultures do not grow well under the electric light of an incubator but do better when shaded. He also states that guinea pigs injected with tubercle bacilli are not effected by the organism if they are allowed to run in direct sunlight. For diagnostic purposes they must be kept in the dark after being injected.

Studies by Sellards[12], of the Harvard School of Tropical Medicine, on the photodynamic action of sunlight furnish some interesting suggestions regarding the nature of heliotherapy. He found that with the aid of certain fluorescent substances such as eosin, acredin and chorophyl the sun's rays may become surprisingly active, approaching in abiotic properties the magnitude of roentgen rays or similar short wave lengths. For example, red blood corpuscles are unaffected by eosin solution in total darkness but are hemolyzed if exposed to sunlight even in dilute solution. He suggests that since malaria parasites are retarded in growth by blue light, the specific action of quinine (a fluorescent substance) may be due to its fluorescent properties in changing ultra-violet rays to blue radiations. Paramecia were killed in six minutes by a 1-20000 solution of acredin in direct sunlight but remained alive indefinitely in total darkness.

I can well remember my experiments in elementary bacteriology in which typhoid bacilli were killed by direct sunlight in five minutes.

All these observations lead one to believe that the benefit derived from heliotherapy is dependent upon the power of the sun's rays to destroy pathogenic organisms and at the same time stimulate the patient's protective powers.

Aside from speculation as to its nature, the practical results obtained by sun-treatment as demonstrated by Rollier, Calvé and an increasing number of clinicians and orthopaedic surgeons in America leave no doubt that its use is not only justified but definitely indicated in bone and joint tuberculosis in all forms and stages.

For its practical application I use the following schedule which is made up after the Rollier method with slight modifications:

	Part exposed	Time exposed	Number of periods
First day:	feet	5 min.	4
Second day:	feet	10	4
	legs	5	
Third day:	feet	15	4
	legs	10	
	thighs	5	

Fourth day:	feet	20	4
	legs	15	
	thighs	10	
	abdomen, fore arms and hands	5	
Fifth day:	feet	25	4
	legs	20	
	thighs	15	
	abdomen, fore arms and hands	10	
	chest, upper arms and shoulders	5	

The length of each exposure period is increased 5 minutes each day up to one hour. The patient will then be getting a total of four hours a day in the sun. The face is never covered but is always shaded by a hat. Sinuses are freely exposed by removing all dressings.

This schedule should be enforced not rigidly but with good judgment. In the beginning, every precaution should be taken to avoid exhaustion, depression, sunburn and exacerbation of the local lesion or general symptoms. Temperature should be carefully watched, also the effect on the blood counts. Another procedure which may yield valuable data is the determination of the basic metabolic rate before treatment is begun and after it is well under way. So far as I know, this has not been done. The hibernation habits of some animals suggest that metabolism is at its lowest ebb in total darkness and probably at its highest in direct sunlight, other conditions being equal. Studies along this line will help to put heliotherapy on a more scientific basis.

Many detailed reports of results are now available to show that the course of so-called surgical tuberculosis is materially shortened and operative intervention avoided by this method. Freiberg[13] reports: (1) a tubercular hip of three years' duration with ten sinuses showed general improvement and all sinuses closed after three months' exposure; (2) a Pott's disease of four years' standing with two sinuses which closed in four months; (3) a tubercular hip with excision of femoral head and profuse suppuration cured in eight months. Campbell's[14] statistics based on 65 cases show cures in 28 cases, 18 of which were exposed from six to nine months and none of which had to be treated more than two years. These cases remained apparently cured for from one to five years. Rollier's[15] earlier records (1129 cases) show cures in 87% of closed cases and 76% of open cases. Of 158 tubercular hips 125 were cured, of which 102 "regained complete recovery of articular function." For comparison let us note the percentages compiled by Humphries and Durham[16] from cases treated at the New York Ortho-

pedic Hospital prior to 1917. Average duration of treatment for tubercular ankles 4½ years, knee 7 years, hip 7½ years, spine 7½ years.

In my experience, cases undoubtedly do better under heliotherapy in many ways which can not be measured as well as in ways that can. The following cases, as well as the above three, have been receiving heliotherapy under my care for periods varying from six months to two years:

Case 4. H. J. Girl of 6. Tuberculosis of right hip. Mother has pulmonary tuberculosis. Only child. Always well until present trouble. Began to limp in right leg in August, 1919, when four years old. Did not complain of pain either on walking or at night in the hip but mentioned slight pain in right knee which did not interfere with walking.

Condition in February, 1921, when first seen by me: General appearance good; well nourished but color poor. Temperature 99. No glandular enlargement. Throat normal. Lungs and heart show nothing abnormal. Abdomen negative. Walks with a decided limp on the right, throwing trunk and pelvis forward when weight comes on that side. Slight muscular atrophy of right leg and thigh. Right leg 45.5 cm., left 47. cm. Motion in right hip limited as follows: extension to 140 degrees, flexion to 90 degrees, abduction to 165 degrees, internal rotation to 80 degrees, external rotation to 95 degrees[17]. No tenderness on palpation or manipulation of the hip. Von Pirquet test negative.

Roentgenogram shows flattening of head of right femur without roughening or other signs of destruction.

Because of the mild symptoms, the negative Von Pirquet and roentgenologic findings and sharp limitation of external rotation, this case was at first regarded as osteochondritis. Extension was applied until flexion deformity was corrected, then a spica cast.

June 25, 1921. Cast removed about six weeks ago. No subjective symptoms since then. Slight muscle spasm. Flexion to 130 degrees, extension to 170. On crutches without weight bearing.

July 29. Injured right hip a few days ago in a fall. Since then she has complained of pain and tenderness. Marked muscle spasm. Put to bed with extension.

August 27. Temperature 99.6. Fullness and tenderness in front of right hip. Von Pirquet positive. Heliotherapy was started a few weeks ago. Roentgenogram showed signs of destruction in the joint. The whole picture was now one of a tubercular hip.

Following the extension, the hip was immobilized in spica cast which, after three months, was replaced by a Thomas brace. The patient tanned well

under sun treatment, being in a favorable location, the foot hills of the Sierra Madre mountains.

The fullness first noticed in August, 1921, became gradually diffuse and fluctuant, evidently an abscess which never broke.

Condition February, 1923: Full color in face and good tan over entire body; robust and healthy. Right hip flexion to 145 degrees, extension to 180, abduction to 160, internal rotation to 70, external to 120. The abscess has subsided so that measurements of the upper thighs at corresponding levels are equal. Slight adductor spasm, slight pain on forced flexion and abduction. Brace and crutches continued for protection.

Although this case is not yet cured the condition is most favorable. It is possible that the tubercular process supervened on the osteochondritis following her fall, since there was a marked change for the worse in the clinical symptoms and roengenographic findings after that.

Case 5. K. J. Boy of 4. Tubercular spine. Seemed perfectly well

Figure 3. Case 5. Beginning caries of XII D and I L.

until about three weeks before admission to hospital in January, 1922, when pain in back began. Roentgenogram (Figure 3) at this time showed narrowing of XII D and I L and of the intervertebral space between them.

Condition in July, 1922. On Bradford frame, ventral (Rollier) and dorsal position alternately. General appearance healthy but rather pale. Very slight kyphosis over XII D but no tenderness. Physical examination otherwise negative.

Had been getting heliotherapy since January, 1922, and this treatment was intensified during the six months beginning July, 1922.

Condition January, 1923. Color is better but tan not as deep as desired. General condition improved. Roentgenogram (Figure 4) shows partial fusion of XII D and I L producing a wedge-shaped mass about the size of one normal vertebra. The bones are more dense than a year ago and the process does not seem to be active. At any rate, it has not spread beyond the original focus. This collapse of these two vertebrae is interesting in view of the fact that the patient was recumbent constantly during the time it occurred.

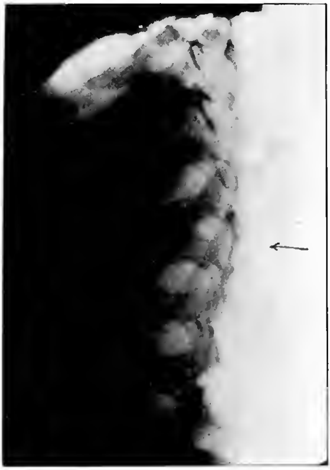

Figure 4. Case 5. Taken a year later than figure 3, showing collapsed vertebrae.

Case 6. M.A. Girl of 4. Tubercular left hip. Father has tuberculosis. A Mexican child from whom history could not be obtained. Roentgenogram taken in May, 1922, showed advanced destruction of acetabulum and head of femur. It has been necessary to keep the hip in spica casts most of the time to prevent adduction but heliotherapy has been carried on as much as possible beginning in July, 1922. Roentgenogram taken December, 1922, showed apparent ankylosis of the hip in slight abduction, the neck in moderate valgus. Practically no motion or tenderness in the hip.

Case 7. J.W. Boy of 11. Tubercular spine with paraplegia. Admitted in October, 1922. For the past five months has had complete paralysis of both legs with loss of sensation from epigastrium down; loss of sphincter

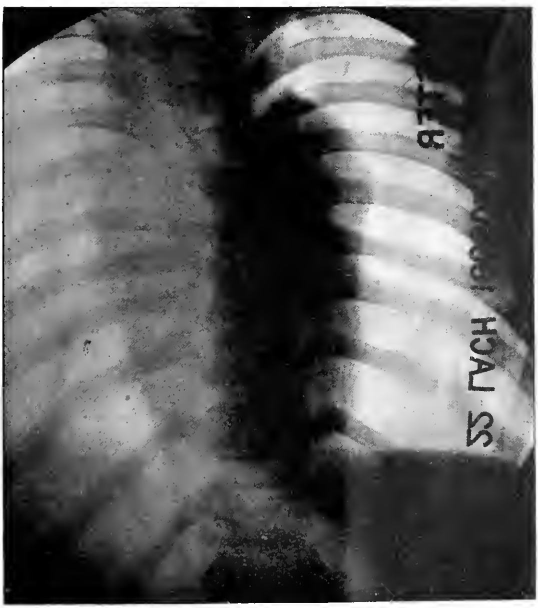

Figure 5. Case 7. Tubercular spine with paraplegia showing abscess pocket which was aspirated through intercostal space.

control. Had an ankylosing operation (Hibbs) in August, 1922, at another hospital.

Condition on admission: Motor and sensory paralysis below level of umbilicus, including bladder and rectal sphincters. Kyphosis from VI D to IX D with discharging sinus about 3 cm. to the left at about the level of VIII D. Roentgenogram (Figure 5) showed involvement of VI D to IX D with dense abscess pocket approximately 10 by 15 cm. in size at this level.

I aspirated this abscess October 11. A small trocar was introduced under local anesthesia, between the sixth and seventh ribs just far enough to the left to clear the transverse process of the vertebra. As the trocar passed through, it was directed toward the midline, hugging close to the body of the vertebra. About 100 cc. of purulent material was evacuated in an aspirating bottle. This method of puncture of spinal abscess is different from that of Calvé[18] who goes through the intervertebral foramen. It is, I believe, safer than the Calvé method, so far as danger to the cord is concerned. It would probably not be possible to employ it, however, except in cases where the abscess is demonstrable by roentgenogram and large enough, as in this case, to find easily with the trocar.

Condition January, 1923: Sphincters are now under control. Knee jerks present. Can flex his knees to about 150 degrees and move feet and toes moderately. All movements very spastic.

CONCLUSIONS

In the three cases under tuberculin treatment the temperature was more regular and lower than it was before treatment was begun. Leucocytosis was stimulated in two of the three cases.

No appreciable effect on the sinuses was noticed. These sinuses, however, were secondarily infected.

Sunlight can penetrate the living tissues to some extent. This penetration is greater at higher altitudes than at sea level or intermediate levels.

Direct sunlight inhibits the growth of tubercle bacillus.

The course of the disease is shortened and the patient's general condition is better under heliotherapy than without it.

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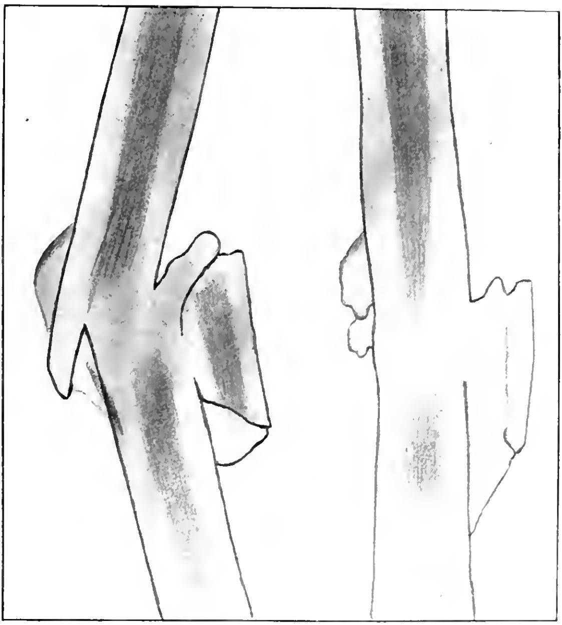
THE LATE CORRECTION OF FRACTURE DEFORMITIES OF THE FEMUR

BY H. WINNETT ORR, M. D., LINCOLN, NEBRASKA

"My experience both in France and in home hospitals compels me to say that the teaching of the principles of treating fractures in general and of their practical application must be vastly improved if ordinary justice is to be done to fracture cases in future. The results of treatment of such cases by those who have become experts in dealing with war injuries show that by careful attention the frequent deformities and consequent incapacities which used to follow comparatively all fractures of civilian life are preventable and should be looked upon usually as due to incompetence or inattention on the part of the responsible surgeon." The above are the words of Colonel H. M. W. Gray, an associate of Sir Robert Jones in the orthopaedic service in Great Britain and France.

I think the sentiments of Col. Gray coincide with those of any one thoroughly familiar with our experience in the military service and present conditions in civilian practice. I have no hesitation in saying that both during my service in military hospitals and in my work since that time I am shocked to see how poor the treatment of most of our fractures is. One of the worst features of the present situation is that in general those who treat fractures, whether physicians or surgeons, show a disposition to be satisfied with the methods with which they are already familiar and with the very poor results which they obtain. This is always a fatal state of mind. In spite of the fact, as Colonel Gray points out, that we now have in this country a considerable number of men who can be classed as experts in this line, neither their advice nor their assistance is sought to any considerable extent in the care of these cases. Instead, relief is usually sought by the disabled patient after an avoidable bad result has become or is becoming a fixed deformity.

I am presenting for your consideration to-day certain points in the late treatment of fractures of the femur for two reasons. First of all I wish to establish the fact that the serious deformities which now exist are in many cases remediable. And second, it is desired to point out that the same methods by which these serious deformities and disabilities can be relieved are those which if applied in early treatment will give good results without deformity and without disability. I shall show lantern slides of only a few cases. The con-



Malunited femur after five months and thirty days after correction by osteotomy and ice tong traction in Thomas splint.

clusions expressed in this paper may be described as impressions, but they are impressions that rest upon the observation of several thousand cases which I have seen treated or which I have helped to treat.

I am now convinced that disability after femur fractures should be the exception instead of the rule, as at present. And I know that the technique of correct treatment and the technique by which good results may be obtained is a comparatively simple matter. The method is one which can be acquired either by physicians or by non-professional men or women in a few days' time. I make this latter statement partly on the experience we had in military hospitals where intelligent nurses and sergeants acquired a proficiency in the treatment of femurs which was often superior to that of doctors who were indisposed to follow details of treatment or who were inattentive to their professional duties in general. Even the use of ice tongs is, as pointed out by Major Pearson, not at all a difficult method.

The exact technique to be employed is as follows,—and this should seldom be varied:—moleskin traction straps, or straps to be fastened to the limb with glue, should be prepared—about three inches wide at the top, about three feet long, and with good rope frayed out and thoroughly sewed in at the lower end for making the traction at the bottom of the splint or cast.

These should be attached to the limb, running well above the point of fracture. In bandaging these straps to the limb, if there is a surplus of moleskin above, it should be turned back down into the bandage. If the Thomas splint is to be used, slip the ring over the foot and up until the back of the ring rests firmly against the tuberosity of the ischium. Keep the limb elevated, maintaining traction while muslin hammocks about four inches wide are pinned across the splint. Let the limb down upon the hammocks, which should be tight enough so that the limb rides well up on the splint. Pull traction ropes down tightly, one going above and one below the bars on either side, and tie snugly at the end of the splint. Put a twisting stick into the ropes about half way between the foot and the end of the splint and twist until there is firm traction on the limb. Bring the lower end of the splint to the outer side of the foot of the bed and turn the limb a little outwards. Fasten the end of the splint firmly to the foot of the bed about six or eight inches above the mattress. Raise the lower end of the bed with blocks or extension legs about eight or twelve inches from the floor. Now suspend the ring of the splint by a rope running through a pulley just about directly over the patient's abdomen and carry the rope through another pulley at the head of the bed so that a weight of ten to fifteen pounds hangs down above the head of the bed. If side pull on the ring is desired a weight of six to

eight pounds may be hung over the side of the bed, attached to the outer side of the ring. Bend the side bars of the splint forward about two inches just above the knee. Be sure that the hammocks across behind the thigh are tight enough so that the femur is bent forward with a natural curve. Finally measure the length of both limbs and twist the traction ropes until the injured limb is as long as the other. Support the foot at a right angle with the leg. Bandage the whole limb snugly into the splint.

If plaster of Paris is to be used—and I usually prefer it—the traction straps are put on in the same way. Anesthetize the patient on a fracture table, attach the traction ropes to the traction device and pull until the limbs are the same length. Put on a double spica to the ankle on the injured side, and to below the knee on the well side. Put a cross bar below the knees between the two legs of the spica. When the plaster has set, turn the traction ropes back over the lower edges of the cast and put on two or three more plaster bandages in such a way as to anchor them, (maintaining traction), and also include the foot thus held in correct position as to rotation of the limb and at a right angle with the leg. Position must be checked by subsequent x-ray through the cast, but if line and length have been secured originally this spica will usually secure healing in six weeks without change in any way. After the patient has been put to bed, the foot of the bed should be elevated and a heavy weight, twenty to thirty pounds, should be fastened to the cross bar between the legs of the spica cast. I find that this contributes greatly to immobilization and to the prevention of muscle spasm in the affected limb. The use of splint or plaster is exactly the same if ice tongs are employed—I usually imbed the ice tongs in the cast just as I do traction straps, and to just as good purpose. I consider the double spica essential.

Length and line are not only fundamental requirements in the treatment of these cases, but they are fairly easily obtained. In spite of this, however, not more than one-tenth of the femur fracture cases that I see under treatment are in correct position as to either length or line. It is a common thing to hear an attending surgeon say after mal-union has developed, that it was impossible to maintain traction. Blame is attached either to the patient or to the apparatus for failure. As a matter of fact the blame for failure to maintain traction should be laid to the surgeon. We do have methods and resources for the control of limbs and for the control of patients which can be made efficient and comfortable. Failure to control the patient may rest upon an excessive amount of suffering or upon a series of disappointments in the early treatment which could have been avoided, and which if avoided, would have made him more coöperative instead of arousing his opposition.

Efficient treatment is not painful. By such treatment relief from pain may always be obtained. It is failure to get length and line and to control movement that causes pain. I am disposed to be very impatient with methods which encourage motion in neighboring joints and at the expense of immobilization of the fragments in a fractured limb. It is my opinion that the excellent results as regards joint movement obtained by Sinclair, Pearson, and others, are obtained not so much because of the fact that they establish early movement, as to the fact that correct line and length have been obtained early and are maintained throughout the course of treatment.

In my own cases I have had the experience of having mal-united femurs come to me with almost completely stiffened knees, and when the mal-union was corrected and correct line and length obtained, a considerable degree of movement returned to the previously stiffened knee. I had one very striking instance of that sort of which I will show you lantern slides.

A man of fifty-four came to me on crutches from Nebraska City in March last year with a mal-united and badly shortened femur (about three inches), which was of about seven months' duration. He came with a history of a comminuted fracture, and also with a statement from two or three preceding physicians that he was an impossible patient to manage. He had been treated by Buck's extension, weights and pulleys, sand bags, etc. X-rays indicated outward bowing with marked angulation of the femur, one large fragment displaced inwards, and a lapping of more than two inches. He had never been able to bear weight on the leg, and there was not to exceed five degrees of knee motion. The lower fragment of the femur was rotated so that the knee pointed almost directly outwards. He was referred to me by his employer and by the Compensation Commissioner, because they were facing the payment of total disability for the remainder of his life, a sum which would have amounted to seven or eight thousand dollars.

This man was placed upon a fracture table and anesthetized with provision for ice tong traction to the femur. Ice tongs were applied and traction begun, then a chisel was inserted into the fractured area, and the old fracture broken up and made to follow the line of the lower fragment in order to give a better opportunity for traction. Upon releasing this fragment with a chisel, strong traction was put on, and we were able to make the leg perfectly straight. The extreme contraction of the soft parts persuaded us to discontinue traction when a length of about three quarters of an inch less than normal had been obtained. The wound was dressed and a double plaster of Paris spica was put on with the ice tongs imbedded in the cast. The patient was quite uncomfortable for two or three days, but had not more than three doses of

morphine altogether. After that he spent about eight weeks in bed, but with no pain or complications. Following this he made daily trips to the office for physiotherapy for about six weeks. He was then walking around on crutches with a caliper splint. No particular effort had been made to move the knee while he was in bed, but immediately upon the application of physiotherapeutic methods knee movement was encouraged, and he has now improved to the extent that he can bend the knee to a right angle without much difficulty. He has been going about as he pleased without braces or crutches now for many months, and is practically a well man. He made a settlement with his employer and with the Compensation Commissioner on a basis of 25% disability some months ago.

We have been taught that we are to expect a man with a fracture of the femur, especially a compound fracture, to be permanently disabled for labor. I am prepared to state that this is not true at all. Early adequate treatment with the limb in correct line and full length, will give as good results in femur fractures as in fractures in any other part. Backward or outward bowing of the femur and external rotation of the lower fragment with shortening are the common faults. These can be entirely overcome by correct use of the Thomas splint. In most of these cases, moreover, control of the fracture becomes less efficient with attempts to move the knee, and my advice is that the knee should not be moved until after union of the fracture in correct line and correct position has been obtained.

I firmly believe that if no attempts had ever been made to establish early motion of the knee in femur cases, our results now would be better than they are. I will admit that there are those like Pearson, for example, who mobilize knees early and succeed in controlling the fracture at the same time. But the attempt to do this on the part of most of those that I have seen destroys the efficiency of the treatment of the fracture and leads to worse rather than better functional results for the limb as a whole.

In a general way my experience leads me to conclude that any patient with a mal-union of the femur who has been disabled to the extent of being on crutches, should be given the benefit of an osteotomy and correct treatment. A man with three and one-half inches of shortening, for example, and with outward bowing, or with an external rotation of the lower fragment, will be very greatly improved by an osteotomy which will correct his bowing and give him an inch or two of length. If the shortening can be lessened so that the patient has shortening of less than an inch, and if any considerable degree of deformity can be overcome, the operation is worth while. If the traction can be accomplished with or without osteotomy at the time of opera-

tion, and a Thomas splint applied in such a way as to maintain the correction and the length obtained, the patient's suffering will be all over within twenty-four to forty-eight hours, and there is nothing to do but to give him six or eight weeks of waiting for a very good result.

On the point of convalescence I have an opinion that differs somewhat from those commonly found in the literature, which state that in these fractures six months to a year must elapse before the patient can bear weight on the limb. We commonly put these patients on their feet in a walking caliper splint in eight to twelve weeks, and expect them to be well in less than six months. Of course, if there is deformity, or if there is much shortening, or there has been so much movement that union is incomplete, a much longer period of fixation and protection will be necessary.

It must be taught, however, and should be taught uniformly and generally by the members of this Association, that mal-unions of the femur, as well as early fractures, may and should be correctly treated so as to obtain correct line, full length, and early recovery by methods which are now available to all. Moreover, any earnest student, either doctor or nurse, can become thoroughly familiar with the necessary technique in a few days time. There is no excuse in the light of our present experience for the poor treatment of femur fractures, either early or late, that is still to be found in every city and village in this country. It is time for us to entirely abandon the double inclined plane, the Liston splint, the Hodgen splint, weight and pulley traction, sand bags, and all the other devices which fail to comply with the fundamental demands of all treatment in fractures of the femur and especially in the treatment of those late conditions where ideal treatment must be the rule.

SOME CONFESSIONS OF AN INTERNIST REGARDING BODY MECHANICS.

BY ROGER I. LEE, M. D.

Henry K. Oliver Professor of Hygiene, Harvard University.

When I came to Harvard University in the fall of 1914, as Professor of Hygiene, I had, I presume, the common conservative attitude of most internists towards orthopaedics. During my Medical School course, my hospital internship, and some years of private and hospital practice, I had watched with the interest of an aloof spectator the development of the specialty of orthopaedic surgery. At the hospital with which I was connected I had seen orthopaedic surgery grow from a weekly visit by an orthopaedic consultant to a very active service. Of course I accepted the orthopaedic treatment of bone tuberculosis and of other bone and joint deformities and also accepted the field of operative orthopaedic surgery. The kind of orthopaedic surgery, however, which is commonly known as medical orthopaedics had not made any very great impression. I had recognized, of course, that in connection with the improper use of the feet various symptoms might well occur and that the orthopaedic surgeon was frequently able to relieve these symptoms. On the other hand, I had not failed to observe that in orthopaedics as in any other branch of medicine there were not only different schools of procedure, but also varying fashions. I viewed with frank scepticism the suggestion that orthopaedic functional disturbances, such as bad posture for example, were connected in any important degree with the fundamental well-being of mankind.

Fortunately when I came to Harvard University it was necessary for me to build up an organization for the care of the student health. I say fortunate because it was possible to accumulate considerable data while working out the fundamental procedures. One of the first steps in the new organization, since the ill were already taken care of, was to create a system of physical examination. This was begun on more or less conventional lines with a strict insistence on medical thoroughness. These medical examinations brought forth many problems. In a general way the most important problem was the creation of a standard for the healthy members of the group being examined. That problem still continues. A considerable portion of the energy

[1]Given in substance before the Boston Orthopædic Club, May, 1922

of the department has been devoted to the investigation of such problems as the occurrence of albuminuria in young men, the instability of blood pressure in young men, the existence of athletic heart, systolic murmurs in normal individuals, etc. With the analysis of the findings of the first group of students examined it became evident that the occurrence of positive organic disease was relatively small: that is, under five percent. However it was perfectly evident that although ninety-five percent of the College population were organically sound, in that no organic defects could be found in any organ or tissue of the body, nevertheless ninety-five percent of the College population were not entirely robust, healthy individuals. At once it became apparent why such tests as the strength test had been introduced into many of our universities as a precautionary measure against the promiscuous participation of the ninety-five percent in athletics. However, the strength test, which is a test of the musculature of the individual, has very apparent faults. It did not seem to be enough that the individual should be organically sound and that he should have certain muscular strength in order that one should be entirely satisfied with his well-being. It seemed reasonable to assume that the strength test was only supplementary in a very limited sense. In other words, an organically sound individual might, by dint of hard practice, surpass a fixed standard in the strength test and probably be not considerably improved over his previous condition. Upon reflection it appeared that a medical examination which detected the presence or the absence of organic defects must be the foundation stone of any critical survey of the individual. But that was the beginning of the problem.

Certain data, mainly along statistical lines, among school children had attracted a great deal of attention to certain standards of nutrition, and rather explicit ratios were suggested, taking into consideration, height, weight, and age. It seemed to us that, on the whole, these ratios were rather arbitrary and that more work needed to be done in this field. We have ourselves made certain investigations in the hope of putting the standard of the nutritional state on a more scientific basis. Even at best, however, the nutritional state is but one phase of the problem of well-being.

I have attempted elsewhere[1] to discuss some of the data secured by scrutinizing the various physiological systems of the body for the purpose of attempting to evaluate the well-being of the individual as a whole. Of course, these systems are very closely interrelated. It also seems certain that the most important system in determining the well-being of the organically sound individual is the central nervous system. In our attempts to evaluate the efficiency of the various physiological systems we have turned our attention

to what has been designated as body mechanics. In dealing with large groups of individuals it has been necessary to restrict somewhat arbitrarily the scope of our observations. We have desired to secure data which could be introduced into an ordinary physical examination. This necessitated that the observations should not be time consuming, should be capable of being carried out by examining physicians who were not specialists and should, if possible, be capable of classification into groups. Dr. Lloyd T. Brown personally made tracings of 746 individuals during one examination season and was able to classify these individuals into four groups, A, B, C, and D, according to the mechanical use of their body, as far as the standing position was concerned. This is obviously only one feature of body mechanics. During some subsequent physical examination periods, using Dr. Brown's charted classification as a standard, the examining physicians undertook to rate all individuals examined. Experience showed that this method was entirely feasible and yielded quite consistent results, even with different and changing examining physicians. As an internist, however, I was far from convinced that this classification was necessarily of real significance. In other words, the question whether it was anything more than of cosmetic value that the individual stood poorly was still undetermined. Sufficient time has now elapsed, however, so that one can generalize concerning the value of this classification. Of course, it must be appreciated that very bad standing position is not necessarily associated with either local or constitutional symptoms. This aspect Dr. Brown and I[2] have discussed in a short paper, "Correction versus Compensation of Body Defects." It is clear that a structural defect of the spine may be largely or entirely compensated for by large muscles. It is also clear that poor function of the spine may be either corrected or compensated. Our experience indicates that compensation by muscles is the rule in the College youth who stands poorly. Most back aches in the college youth are traumatic or infectious in origin. The back aches which are not traumatic or infectious seem inevitably associated with very bad body mechanics. Experience also shows, rather to our surprise, that functional disturbances of other systems, for example, vasomotor instability or even nervous instability, tended to be associated with poor function in body mechanics.

There is one functional disturbance which I desire to mention more in detail. Ever since we began physical examinations in 1914 we have been very much interested in the occurence of albuminuria in apparently healthy young men. It became evident early that such an albuminuria without the other signs of nephritis was of no serious moment. It also became evident that it did not occur in the best physical specimens. In following up these cases of albuminuria, which occur in as high as six percent in the Freshmen,

we find that there is general tendency for albuminuria to disappear with age. There are certain individuals in whom the albuminuria persists. This albuminuria is present throughout the day but is not present in the early morning after a night in bed, and is usually called functional or orthostatic albuminuria[3]. Our investigations have not been concluded with this interesting group of cases, but it seems reasonable to assume that these individuals show albumin on very slight activity, whereas it is well known that the ordinary individual requires very violent exercise to show albumin. In checking up these individuals with orthostatic albuminuria it was surprising to find that a considerable proportion of them had been previously classified as having very bad body mechanics and were in our group "D." I am certainly not prepared to state that the bad posture is the cause of orthostatic albuminuria; I am only prepared to state that the two conditions are often associated. It seems likely that the poor function in one system is merely associated with a poor function in another system. It is only fair to add that it has not yet been determined how far the correction of bad body mechanics will go towards removing the albuminuria. The association of bad body mechanics with other functional disturbances of other physiological systems is sufficient to make us believe that the classification of bad body mechanics is of definite value. I do not believe, of course, that the classification of an individual's body mechanics is a classification of the individual as a whole, but it seems to me that it is an important contribution to the evaluation and survey of the individual as a whole.

Very bad body mechanics is naturally of more significance when it is associated with a disturbance of function of another system. It is possible to have very bad body mechanics without disturbance in another system. How long the body mechanics may be compensated for without local disturbance or without associated disturbances, it is not possible to say. It is certain that many persons go through life with very bad body mechanics and apparently without positive ill-health therefrom. On the other hand the experience with bad body mechanics in middle life, when the bad habit has become fixed, is a strong additional argument for the early correction of this condition. It is interesting in this connection that, as one might expect, there is a high correlation between good body mechanics and athletic prowess. It is also interesting that there is some correlation between good body mechanics and the intelligence rating in one of the graduate schools of the University. The latter point deserves some emphasis because of considerable confusion arising from a misinterpretation of certain data. The obvious fact has been given great emphasis that the ability to attain high excellence in such physical

performances as jumping and running is not associated with high scholarship[4]. I say "obvious" because one would expect that technical excellence in given physical events would, as a rule, be attained at the expense of technical efficiency and interest in scholarship and vice versa. As physicians interested in health we are not primarily interested in technical or trained physical excellence but in general well-being.

As I have tried to indicate, I do not believe that such a method as has been outlined does anything more than form a basis of evaluation of one part of one physiological system. That the method is crude and rough and deals in generalities is certain. Any form of classification into large groups is bound to deal in generalities. This method does not discriminate sharply between different types of individuals, more notably the thick set and the slender individuals. Nevertheless, despite obvious short-comings, such a method has won favor in my somewhat sceptical eyes, and it seems to me very useful not only in the examination in large groups but in the critical survey of individuals in a general practice. As far as I know, the examining physicians who have assisted me in the examinations not only have become convinced of its value, but have found such a method useful in private practice. To my mind the greatest danger is in over emphasis of such a method by attaching to such an evaluation of one physiological system more value than it should have. The total evaluation of the physical activities of the individual, while taking the evaluation of the body mechanics into consideration and serious consideration too, will also take cognizance of many other factors.

We have attempted to utilize this general method to evaluate the use of the feet. From the nature of things the use of the feet represents much more of a local problem. It is reasonably certain that poor use of the feet is much less closely related to possible constitutional disturbances than poor mechanical use of the body. By poor use of the feet we, of course, mean poor use of the feet from an orthopaedic point of view, not merely absence of transverse arches or low posterior arches. Symptoms develop much more rapidly from poor use of the feet than from poor standing position. There is, however, the same factor of muscular compensation for poor use of the feet as has been discussed in poor standing position. There did not seem to be any close association between poor use of the feet and functional disturbances of the body, but, as one would expect, there was some association between poor use of the feet and poor standing position. Our experience has indicated that any arbitrary classification into four general classes of the use of the feet is roughly satisfactory both in large groups and individually. Perhaps the most encouraging feature of this aspect of our work has been the ease

with which good habits of the use of the feet can be substituted for bad habits by a little instruction and encouragement both before and after there are symptoms. Our experience indicates that the feet with which not much fault can be found and which are generally passed as representing fairly good use may need definitely more instruction than it has seemed necessary to give in the past. Other factors such as shoes, which we always investigate, and strain on the feet, such as prolonged standing or running on hard surfaces, must be taken into consideration.

In conclusion, a conservative view point would seem to be that bad body mechanics as far as it concerns posture and the use of the feet does not under the artificial conditions of our present day civilization tend to correct itself spontaneously. Whether the underlying cause for the failure of Nature to secure correction is to be found in the home, in the school, or in uncorrected habits after illness, is not apparent. Seemingly a majority can be benefited by intelligent instruction in good habitual use of the body and the feet. Inasmuch as habits once formed are difficult to break, it is important that good habits be established as early as possible. It would seem to be important to establish good habitual use of the body and feet in the growing period or in the schools and, of course, before college age. Our experience definitely indicates that such measures which are entirely feasible will presumably show excellent results in middle life. Finally again it must be emphasized that important though the body mechanics is, it is only one of the systems of the human body, and any evaluation that confines itself to one system will leave out of consideration many factors that may be of paramount importance.

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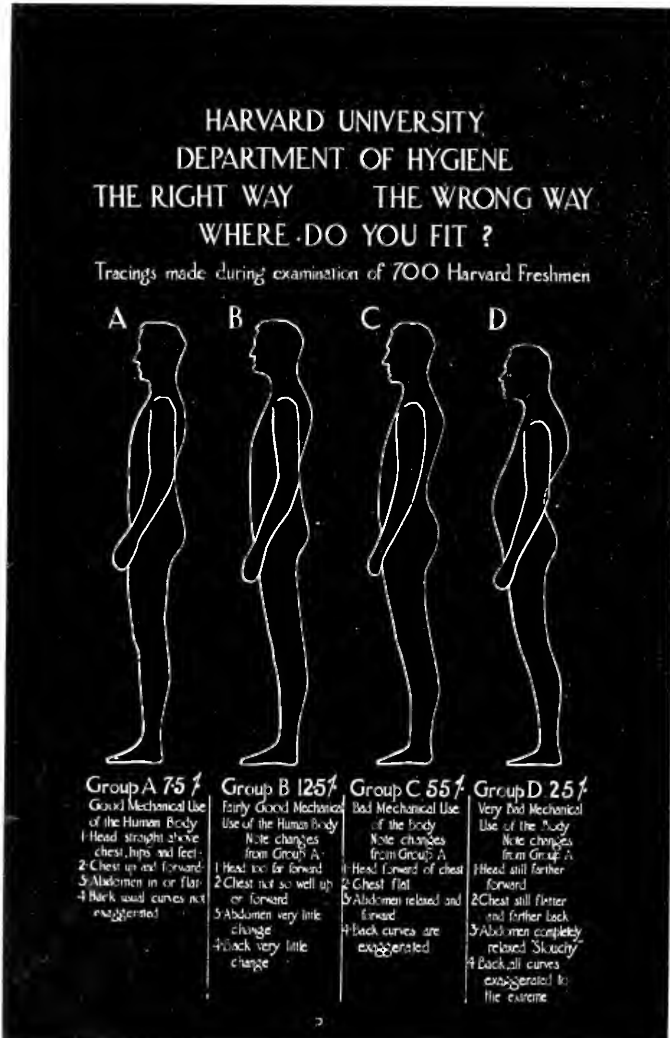
A NEW CHART FOR THE STANDARDIZATION OF BODY MECHANICS.

BY ROGER I. LEE, M. D., AND LLOYD T. BROWN, M. D.

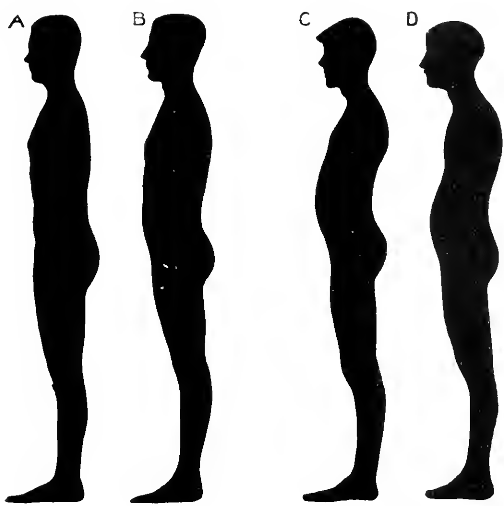
Some years ago the Department of Hygiene at Harvard University, in connection with the regular physical examinations, found it practicable to have a method of standardization by which it was possible to make fairly quick and accurate judgment of the body mechanics of each individual examined. A chart (Figure 1) was developed by Dr. L. T. Brown[1] from tracings made from 746 individuals who presented themselves for examination in October, 1916. Experience with this chart used as a standard has shown that it is possible to get fairly uniform and consistent results over a series of years with different groups of students and with different examining physicians. It has furthermore been our experience that the rating by the examining physicians corresponds very closely to the rating given on the basis of tracings. The method used is that the examining physician rates how the individual uses his body during the period of examination, particularly when the individual is relaxed and is not making a special effort to show how much he thinks he knows about the correct use of his body. This point seems important because, on the one hand, some students, who habitually use the body badly, have been coached how to take a good mechanical position and so assume it when they think it is necessary, and because, on the other hand, some students, who habitually use their bodies well, will artificially assume a very incorrect position when attempting to stand well. The method of continuous observation has this advantage over the method of securing tracings, in that it seems to be a fairer test of the habitual use of the body.

Although the old chart, (Figure 1) has been on the whole very satisfactory, nevertheless, it has several very definite faults. The most marked fault seems to be in Figure A. Figure A represents what should be essentially perfect body mechanics. Comparing the old chart with the new one, (Figure 2) the difference between the two can be easily seen. Furthermore, the new chart is made from individuals who belong to the type of narrow, thin individuals. This type is chosen because it is the type in which for anatomical reasons the most marked changes can be seen, and this type is commonly found in the "D" group, or those with bad body mechanics. It is not feasible, and in our experience it is not necessary, to have different sets of charts for the different


HARVARD UNIVERSITY
DEPARTMENT OF HYGIENE
THE RIGHT WAY THE WRONG WAY
WHERE DO YOU FIT ?
Tracings made during examination of 700 Harvard Freshmen
A
B
C
D
Group A 7.5 %
Good Mechanical Use of the Human Body
1 Head straight above chest, hips and feet
2 Chest up and forward
3 Abdomen in or flat
4 Back usual curves not exaggerated
Group B 12.5 %
Fairly Good Mechanical Use of the Human Body
Note changes from Group A
1 Head too far forward
2 Chest not so well up or forward
3 Abdomen very little change
4 Back very little change
Group C 55 %
Bad Mechanical Use of the body
Note changes from Group A
1 Head forward of chest
2 Chest flat
3 Abdomen relaxed and forward
4 Back curves are exaggerated
Group D 25 %
Very Bad Mechanical Use of the Body
Note changes from Group A
1 Head still farther forward
2 Chest still flatter and farther back
3 Abdomen completely relaxed "Slouchy"
4 Back, all curves exaggerated to the extreme

variations in the type of individuals. It must, however, be appreciated that the stocky thick-set type is quite different from the narrow thin type and that there are anatomical variations of the bones and muscles which make a difference in the amount of relaxation possible.

The legends under the figures on the chart explain the special point of each and are followed in making the ratings. The individuals who have been rated as "D" have in the past been given a special examination in the gymnasium, where a graphic record was taken. There have been very few discrepancies between the graphic records and the ratings at the time of the examination. This group rated as "D" has had the benefit of special instruction in body mechanics. Our experience has convinced us that a rating of "D" is certainly a potential handicap. It is our experience, furthermore, that with the reasonable coöperation it is nearly always possible for a "D" individual to improve his rating. The justification of such endeavors is becoming more clear with the accumulating evidence that the muscular compensation of defects in body mechanics, which is so common and so easy in youth, not infrequently fails when active physical exercise is given up for a sedentary life. This feature has been discussed by us elsewhere[2].



Some form of graphic record is often very valuable for a variety of reasons. The graphic record furnishes a permanent record for purposes of comparison. It is frequently of great value in gaining coöperation in attempts to achieve correction of bad body mechanics. The graphic record can be used furthermore as an excellent check on the accuracy and consistency of ratings by observation. A new method of taking the graphic record has been worked out by Norman W. Fradd of this Department. This method is very quick, inexpensive, and accurate. It does away with the personal equation which is such a large factor where tracing an image is necessary.

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A NEW METHOD OF RECORDING POSTURE

BY N. W. FRADD

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In the physical-medical examination of Harvard Freshmen an attempt is being made to classify them regarding their body mechanics from an orthopaedic standpoint. Examinations of the past four years have annually placed one third to one quarter of the class in a "D" rating, which signifies very poor body mechanics. This rating also carries with it the opportunity of special exercises and instruction sometime during the winter months. In an effort to demonstrate to the individual the need for improvement a tracing camera has been used, and each Freshman classified "D" is given a tracing of himself. This hand tracing camera is poor at best and, although used extensively, is inaccurate and wastes much time.

During the past year experiments have been carried on at Harvard in the Hemenway Gymnasium by the writer and a photographic expert to record the posture of Harvard Freshmen given the rating of "D." Realizing that photography was by far the most accurate and satisfactory method to use, though expensive, it was our aim to produce an actual photograph with the minimum expense, eliminating the services of a photographer in printing and developing. The operation must be short with reference to time, and the record must be accurate to be of any permanent value. The outcome of these experiments has been the development of a camera and other features which give the desired result.

The camera is sold under the name silhouetteograph*. The picture produced for record is an actual silhouette. The use of a film or plate in the camera is eliminated by substituting a sensitized bromide paper which can be put through the developer and fixing bath in two or three minutes, after which the picture is ready for inspection, criticism, or commendation. One of the features of the camera is a movable plate holder which allows for one, two, four, or twenty-four exposures on five by seven inch paper, depending upon the size of the picture desired. It can be seen at once that with such an arrangement the camera is adaptable for use in private clinics or public schools.

The space required for making a picture like the one suggested above is about fifteen feet long by six feet wide. In setting up the outfit an electric bulb of 1000 watts in a suitable reflector is placed about five feet behind

*The equipment used by the writer was obtained from Robey French Company, Boston, Mass.

a screen made of architects' tracing linen. (Linen is used because it is a better diffusing surface than cotton.) The screen should be about seven feet long and three feet wide supported on a frame or shade roller. The lighting source should be moved forward or back and raised or lowered to give an even distribution of light on all portions of the screen. The distance between the screen and the camera is about ten feet. With the apparatus set up as described the subject stands close to the screen in the space between camera and screen, with the right or left side of the body toward the lens.

The picture obtained is an actual silhouette reversed; that is, the subject is white on a black background instead of black on a white background. The time required for the exposure is about five seconds. This is governed somewhat by the intensity of illumination in the flood light and the speed of the lens. To obtain the best image the space between the camera and the subject should be darkened to give a clear sharp silhouette. The pictures may be numbered for filing or identifying by inserting a stencil at some convenient place on the diffusing screen.

The matter of expense is, as stated above, a drawback when pictures are considered. The actual expense of this entire operation is about one cent or less per picture, depending upon the size.

The writer considers it a great advantage to produce the picture for inspection by the subject immediately after taking. The impression made on the subject that "probably there is room for improvement" paves the way for instruction, whereas any amount of talking or looking in mirrors might prove ineffective. The interest of the student is at once aroused, and with a bit of tact the instructor has the opportunity to suggest ways and means of correction. Successive pictures may be taken to record improvement in posture. With a slight change in lighting effects lateral deviations of the spine may also be recorded.

ACTINOMYCOSIS AND BLASTOMYCOSIS OF THE SPINE.

BY CHARLES A. PARKER, M. D., CHICAGO, ILLINOIS.

An undiagnosed case of blastomycosis of the spine, with a fatal ending, in my practice a few years ago, and a previous undiagnosed case of actinomycosis of the spine, also terminating fatally, are my reasons for presenting the cases in question, along with a discussion of the conditions under which these rarer affections of the spine occur.

Although the occurrence of general infections in these diseases has been known for some time and the spine recognized as an occasional site of infection, it seems worth while at this time to emphasize the spinal feature and bring together the scattered records of such of these cases with spinal involvement as have from time to time appeared in the literature. The writer does not know of such a special compilation. Such an assembling of isolated instances of related facts serves to concentrate the attention upon the subject and give anew its proper perspective in the medical view.

ACTINOMYCOSIS.

To Bollinger, of Munich, (1887) is given the credit for discovering the nature of the infection in lumpy-jaw cattle. The following year Israel discovered a similar organism in man, which Ponfick shortly after found to be identical with that discovered by Bollinger, thus demonstrating the same causative factor of the disease in man and the lower animals. These were the real discoverers of the true nature of the disease. Following these investigations, a number of undiagnosed clinical cases in man and animals that had occurred before this time were brought to light in the Italian, French, English, and German literature. Israel quotes Langenbeck, as far back as 1845, as describing a case of caries of the lumbar spine with yellow grains in the pus and other characteristic features. Israel believes this was undoubtedly actinomycosis.

Perhaps this is the earliest spine case of which we have any record.

Following the studies of Bollinger and Israel, reports of the disease in man began coming in from various countries on the continent of Europe, later from England, in 1884, and then from the United States, in Chicago, in 1885. It has since been found in most of the countries of the world. The presence in the pus of sulphur colored, white or greenish microspic to

pin-head-sized granules containing the specific ray fungus, or recognition of the organism in the tissues, establishes the character of the infection.

No attempt will be made to repeat in detail the well known clinical features of the disease but attention is called to Ruhrah's statistics published in 1899, reporting 1094 cases. In 421 of these collected by Inich, the sites of distribution were as follows: Head and neck 56%, pulmonary 15%, digestive tract 20%, skin 2%, doubtful 6%. This enumeration does not mention the spine, as it evidently refers to the site of the principal disturbance, although he does state that the spine is the favorite site of bone lesions. In quoting the same statistics two years later, Erving says the ribs and vertebrae were affected in 9 cases, or in a little over 2%. These are the best reviews in the literature covering particularly the United States and Canada, with much detail regarding geographical distribution and other important statistical information. (Later.) A review by Sanford, *J. A. M. A.*, Aug. 25, 1923, of 678 cases in the United States has just appeared. Spinal invasion is not mentioned.

In a careful review of the literature since the publication of these reports the writer has been able to find but seven reported cases of definite infection of the spine. To these may be added one unreported case and the one herewith reported by the author, making a total of nine. A compilation of all cases of actinomycosis in man since 1902 was not attempted, so the percentage of spine cases was not determined. It is plainly evident that many more spinal cases than those reported have occurred, yet the small number reported shows that its recognition as a clinical feature is not common. This is largely due to the fact that the invasion of the spine is always secondary and its symptoms are usually obscured by the more obvious primary manifestations, and to the equally unavailing fact that deformity of the spinal profile rarely occurs. The invasion of the spine may be determined by the localized pain, cord symptoms, rarely deformity, and by the use of the x-ray. Often it is found only at autopsy.

A short résumé of these later reported cases will furnish a good composite pathologic picture of the local changes and accompanying symptoms.

Summary of Cases.

Boström's case, 1890, was that of a woman 40 years old, who, besides other thoracic symptoms, had severe pain in the thoracic spine with abscesses and numerous fistulae in the back. At autopsy the spinous processes were found more or less carious and softened. The dorsal vertebrae from the 1st to the 8th showed loss of periosteum. The bodies were markedly carious, soft, and easy to cut with a knife, with large and small cavities filled with granulations. Corresponding heads and portions of the ribs were cari-

ous. No osteophytic growths were observed. Slight compression of the bodies in places was observed, being most marked in the 8th. The accompanying illustration taken from his article is classic. Fig. 1.

Ginsberg's first case, 1890, was that of a woman 40 years old. She suffered from pain in the chest and back, which was followed by abscesses and fistulae. The post-mortem showed worm-eaten cavity building destruction of the spine extending from the 2nd to the 8th dorsal vertebra, causing a scoliosis to the left.

The transverse processes and ribs at their angles were also affected.

The second case was in a male 6 years old, with abscesses and fistulae along the spine.

Beside the lung infection, the post-mortem showed erosion of the upper dorsal vertebrae and ribs.

In Bevan's case, 1905, the post-mortem report on the distribution adds "then the sacrum, spinal column and cord". There is no mention of change in the spinal profile.

J. K. Young's patient, 1908, was a man 31 years old. No kyphosis was present and movements of the spine were normal. There was swelling of the dorsal tissues with sinuses. X-ray showed "superficial lesion of the angles of the 2nd and 3rd ribs, left side, but no lesions of the vertebrae." Autopsy disclosed "many small and large abscesses in the muscular tissue and intermuscular tissue beneath the periosteum from the 1st cervical to the 1st lumbar vertebra. The 10th dorsal vertebra was denuded of periosteum and communicated with a large cavity. The spinous processes of the lower dorsal vertebrae were infected."

Kolacek, 1914, mentions the 1st to the 3rd lumbar vertebrae being eroded, with a perinephritic abscess.

Guleke's case, 1921, was that of a man 53 years old, suffering from neuralgic pain in the left side of the chest. Early x-ray was negative. Two years later x-ray showed changes in the 3rd and 4th dorsal vertebrae with reflex spinal rigidity and slight right sided scoliosis. At operation, the 2nd and 3rd dorsal vertebrae were found "highly carious" and were scraped out. This healed. Two years after this another operation was performed, with recovery of the patient. He states he has not observed in the literature a deforming of the spine from actinomycosis.

The unreported case, 1922, occurred on the service of Dr. Dean Lewis in the Presbyterian Hospital. The patient was a woman, 30 years old, with sinuses on the back discharging pus from the deeper structures, presumably the kidney. Autopsy disclosed an abscess connected with the left kidney and direct extension of the infection to the bodies of the 12th dorsal and

the first four lumbar vertebrae on the left side. The 1st and 2nd lumbar vertebrae were one-third destroyed on this side. The process was found in the lungs. There was no deformity of the spine. The diagnosis was made from the autopsy material.

The author's case. The patient was a male, aged 22 years, a farmer by occupation and a resident of Michigan. He was first seen in October, 1913, giving a history of an operation for appendicitis the previous May. The wound had not healed and there was a copious discharge of pus, with other collections of pus in the lower right side of the back. For this condition he was sent to the Presbyterian Hospital and the abscesses drained. Repeated examinations of the pus did not reveal the true cause of the infection. The patient died six weeks after entering the hospital. A few days before death there was some loss of control of the lower extremities, but no deformity was present in the spine and no symptoms had been attributed to it. No x-ray was made. The following is the pathologist's report: "There is a large cold abscess surrounding almost the entire lumbar spine and extending downward in either psoas muscle to the inguinal region. The muscles attached to the spine both laterally and posteriorly are extensively broken down and infiltrated with yellowish pus and granulations. The sides of the bodies and transverse processes of the vertebrae are extensively eroded and covered by the same granulation tissue. On sagittal section of the lumbar spine the erosive process is found to extend through its bodies, and a large granuloma has formed between the anterior surface of the dura and the posterior surfaces of the bodies of the 3rd, 4th and 5th lumbar vertebrae. This grayish yellow granulomatous tissue has almost completely collapsed the dural canal from front to back and has compressed the enclosed fibers of the cauda equina. The inner surface of the dura and the contents of the dural canal are uninvolved by the inflammatory process. The nerve roots outside the dura are surrounded by granulomatous tissue. The intervertebral discs show only slight changes. See Figs. 2, 3 and 4.

Microscopic Findings: Sections of the infiltrated bone and of granulations surrounding the vertebrae show typical actinomycotic changes. There are areas of bone destruction by lacunar absorption with replacement by granulomatous tissue composed of round and epithelioid cells, fibroblasts and degenerated tissue. Occasional colonies of ray fungi are seen, surrounded by an inflammatory zone. See Fig. 5.

A more skillful search by the pathologist of curetted materials or an x-ray would in all probability have revealed the true condition. Had this been done early, cure might have resulted.

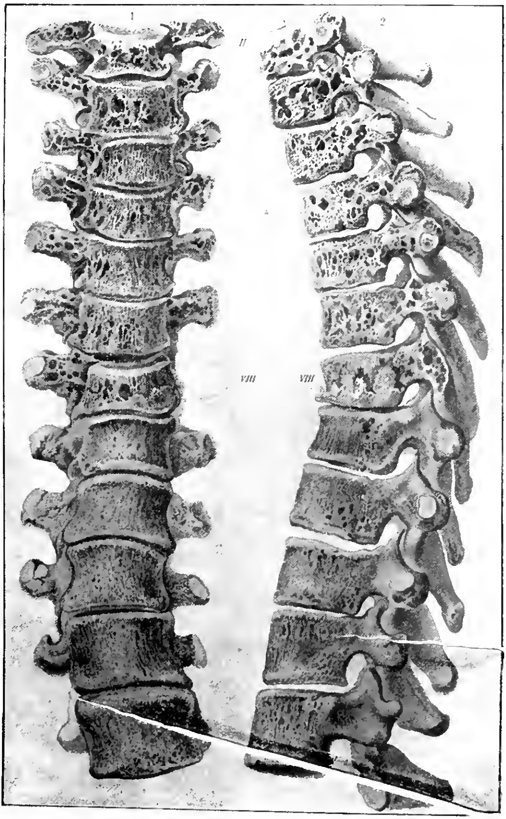

Figure 1. Bostrom's classic illustration of actinomycosis of the spine taken from the Beitrage zur pathol. Anatomie, Bd. IX.

Diagnosis.

In Guleke's case and in Ginsberg's case slight scoliosis was mentioned, and in Boström's case a slight deformity could possibly have resulted from compression of the vertebrae, but the amount of compression was so slight that the deformity could easily have escaped recognition. In Guleke's case much of the 2nd and 3rd dorsal vertebrae was curetted out with little tendency to collapse. In none of the other six cases were there any symptoms directly referring to the spine, unless the late paralysis of the

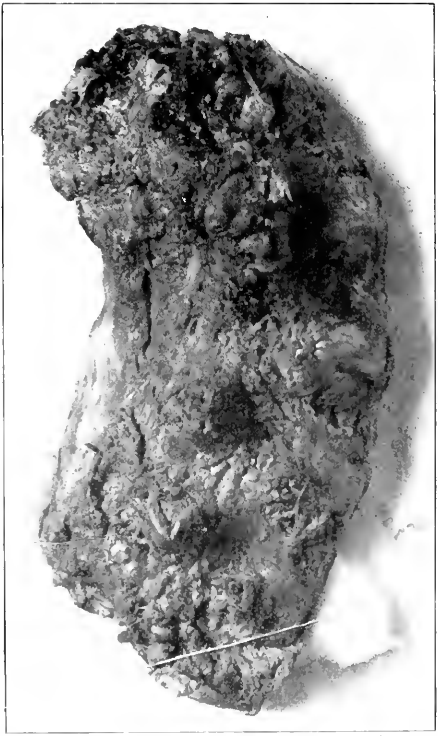

Figure 2. Actinomycosis of Spine. Gross specimen showing position of psoas abscess with breaking down of muscular tissue and erosion of the vertebrae.

lower extremities in the author's case. Thus it is evident that little help is to be derived from changes in shape of the spine although it is said that the deformity may resemble that of Pott's disease.

Spinal symptoms appearing in a patient known to be suffering from actinomycosis should naturally suggest the possible cause of the spinal disturbance and determine the necessary local diagnostic measures, such as

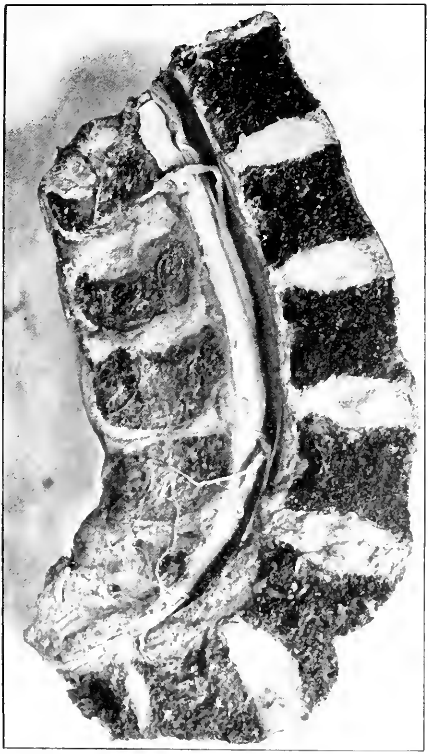

Figure 3. Sagittal section showing extent of osseous invasion and destruction. A large granuloma lies between the anterior surface of the dura and the posterior surfaces of the bodies of the 3rd, 4th and 5th lumbar vertebrae. This has compressed the cauda equina.

x-ray and possibly examination of curetted material to decide the causative factor.

Similar spinal symptoms in a person suffering from an undiagnosed general infection would put the diagnosis one stage farther away, necessitating first the diagnosis of the general condition and then of the spinal.

In occult cases where the spinal conditions predominate, all possible factors must be considered, actinomycosis among them. The x-ray will play an important rôle in the decision. Perhaps serologic reactions may eventually come to our aid.

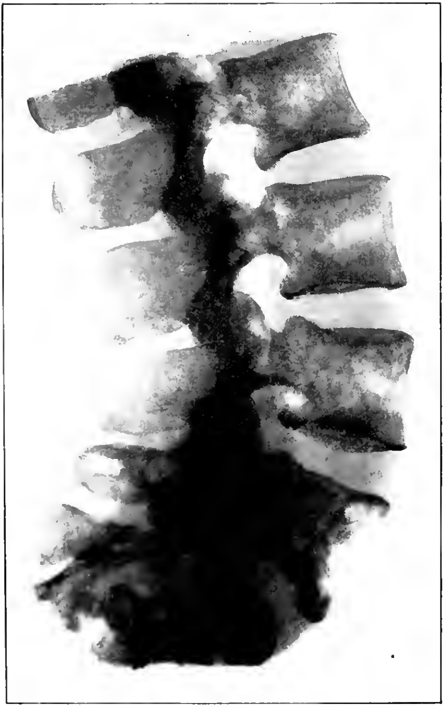

Figure 4. X-ray of specimen showing the peculiar patchy appearance of the affected areas in all the bodies and pedicles without collapse of the bodies, an appearance unknown in tuberculosis.

Treatment.

The treatment depends upon the orthopaedic condition presented. If there is deformity, such protective measures as are used in Pott's disease should be considered. With compression of the cord, laminectomy would be indicated. Guleke curetted out the centers of the 2nd and 3rd dorsal vertebrae and obtained the only recovery in this group. General measures are operative, with the use of large doses of potassium iodide.

Prognosis.

The prognosis is necessarily grave, as the spinal infection is secondary to an already developed focus elsewhere. As stated above, all the patients but one died from the infection. In the 100 cases of generalized infection reported by Erving, 45 recovered: improvement took place in 14; no improvement in 9, and death was recorded in 32 cases.

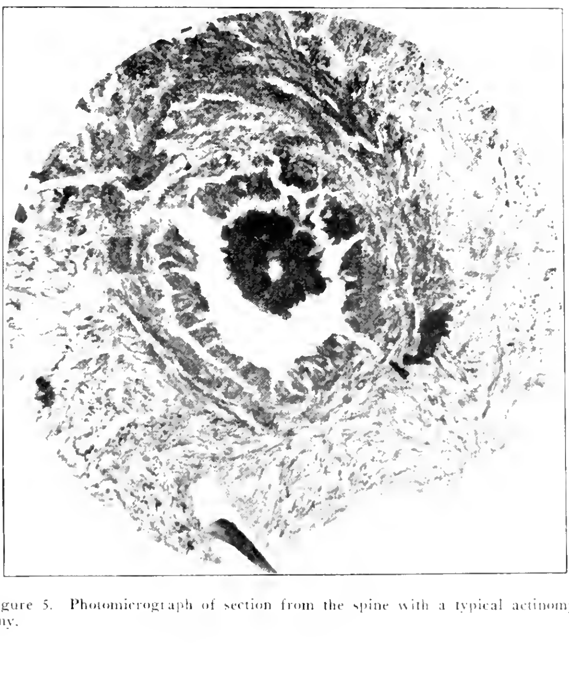

Figure 5. Photomicrograph of section from the spine with a typical actinomycotic colony.

In the abdominal cases 5 out of 23 recovered.

The spinal cases were not recorded separately. However, their possible recovery would be a part of the general healing process and the earlier its recognition the greater the possibility of a cure.

Figure 6. Blastomycosis of Spine. X-ray showing alteration of the body of the 4th thoracic vertebra with definite fracture of the neck of the right 4th rib.

BLASTOMYCOSIS.

The author's patient was a married man, 27 years old, who was first seen in June, 1918. At that time the following history was obtained: In December, 1916, patient first noticed distress from "gas in the stomach." He had incompletely recovered from a pneumonia of the previous winter. With the stomach trouble he had pain extending around the chest toward the back. Back now hurt severely most of the time. The patient was tall and pale. Back was rigid in lumbar region, tender on pressure to the left of the 10th dorsal vertebra. No kyphos.

X-ray showed very little bone change. There was a dense shadow opposite the 5th and 6th dorsal vertebrae that suggested an abscess. No lipping of the vertebrae. Diagnosis of tuberculosis of the spine was made and a brace

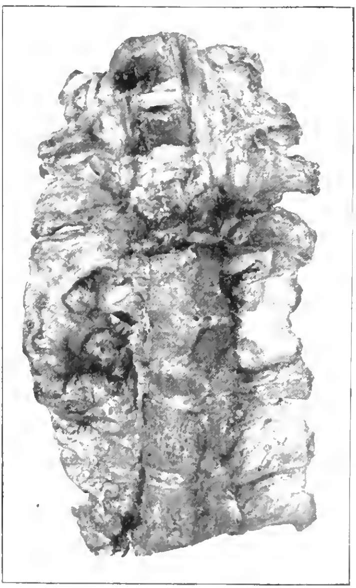

Figure 7. Gross specimen showing erosion of bodies of thoracic vertebrae with complete destruction of the pedicles of the 4th.

with recumbency was advised. This advice was followed, but in August the patient was brought to the Presbyterian Hospital, as he had not improved at home.

Here a thorough medical examination was made by a very competent internist, but nothing regarding the true nature of the condition was disclosed. On Nov. 4th, 1918, the following notation appears: "Has gradually grown worse. Complains of severe pains extending around the chest at the 4th rib. Now is completely paralyzed in motion and sensation in all parts below the navel. A recent x-ray shows the 4th dorsal vertebra mottled and partially

Figure 8. X-ray of specimen showing destruction of the necks of both 4th ribs and partial erosion of the body of the 4th thoracic vertebra. Part of the extensive destruction is due to the portion resected for study. There is little collapse of the vertebrae.

decalcified and the neck of the right rib fractured with the same structural appearance. (See Fig. 6.) Is constantly kept under morphine. Mind clear." With the change in the x-ray appearance the diagnosis was changed to malignancy, type unknown. Repeated examinations of sputum did not give a clue to the infectious agent.

Actinomycosis was considered because of previous sad experience, but there was no evidence of a primary focus; no sinuses or skin lesions.

The patient died on the 9th of December. At the post-mortem a burrowing abscess containing about one-half ounce of grayish pus was found extending along the left side of the 4th, 5th and 6th dorsal vertebrae, the 4th dorsal vertebra was extensively destroyed, and the right and left 4th ribs were fractured by disease of their necks. Pressure necrosis of the spinal cord was present at the level of the 4th thoracic vertebra. Firm adhesions bound the left lung to the spine in this region. Numerous hard nodules were scattered throughout portions of both lungs, which later proved to be blastomycotic.

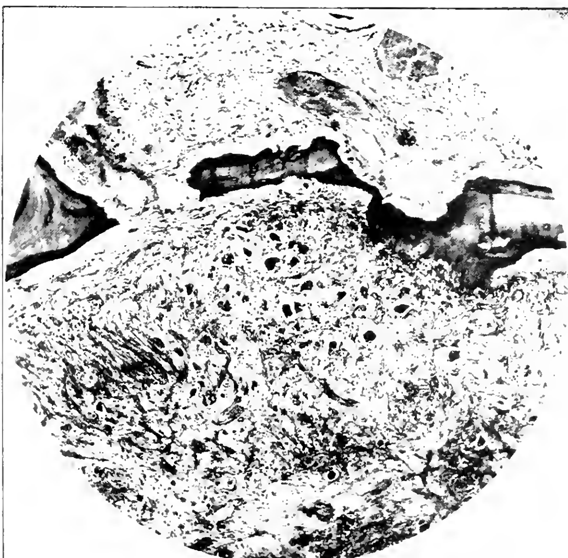

Figure 9. Photomicrograph of specimen taken from the spine showing invasion and lacunar absorption of bone. Numerous giant cells and fibroblasts are present.

The 4th to the 9th vertebrae were invaded by the infection.

The specimen was x-rayed to determine more detail of the process, and microscopic sections were made to show the method of attacking the bone. See Figures 7, 8, 9.

Following is the pathologist's report:

"There is an abscess about the bodies of the 3rd to the 7th thoracic spine, which extends laterally on to the anterior surfaces of the ribs and into the spinal canal, completely encircling this segment of the dura. The arch of the fourth thoracic vertebra has been destroyed, except for the spinous process, but the other arches show only slight erosion of the pedicles without involvement of laminæ or transverse processes. There is marked surface erosion of the bodies and intervertebral discs and of the anterior portion of the pedicles and the ribs which bordered on the abscess. None of the involved bodies are collapsed, and section of the 4th, which is the one most extensively eroded, shows that the involvement has been from without, as the interior is quite broken down. The first portion of either 4th rib is extensively eroded and destroyed for a distance of three quarters of an inch. The arches of the other vertebrae are little involved, except the pedicles, which show considerable surface erosion. There is considerable granulation tissue covering the eroded bony surfaces and filling much of the space between outer surface of dura and the walls of the surrounding vertebral canal. The bodies of the 4th to the 7th were removed and the dura opened from the front. There is direct extension of the inflammatory process through the dura on the anterior surface of the cord opposite the level of the 4th vertebra, forming a flattened mass about 1.5 cm. long and compressing the cord from the front and left side. The rest of the cord and meninges are free from inflammation. The roots of the nerves emerging in this vicinity run through inflammatory tissue about the meninges and arches. It is difficult to state in which vertebra the process began, but it was probably the 4th thoracic, inasmuch as its arch was so extensively destroyed and its body showed the greatest amount of superficial erosion." (See Figs. 7 and 8.)

Microscopic Findings: A section was taken through the body of the 4th dorsal vertebra, including a portion of the 3rd intervertebral disc. About the irregularly eroded surface of the body there is a layer of inflammatory tissue which extends to varying depths within the vertebra. The external portion of inflammatory tissue is composed largely of round and epithelioid cells with extensive areas of necrosis, while the deeper portions contain large numbers of giant cells and fibroblasts. The outer bony trabeculae show extensive lacunar absorption. The uninvolved bone marrow of the interior is slightly more hyperemic and fibrous than normal. The intervertebral cartilage is eroded by granulation tissue at its limits, but is unchanged in its

central portion. A few polymorphonuclear leukocytes are present in the more extensively degenerated portions of the inflammatory tissue. Blastomyces could not be definitely identified in the specimens stained with eosin and hematoxylin. (See Fig. 9.)

This was an occult case with the spinal, or orthopaedic, symptoms predominating and obscuring the pulmonary.

BLASTOMYCOSIS IN MAN.

Busse, in 1894, published his first account of a pyaemia caused by a yeast. Curtis, in 1896, published a complete study of a case in which myxoma-like tumors were caused by a yeast-like organism, the patient having come under his observation the year before. In both of these cases bone and other deep tissues were affected.

"To Gilchrist belongs the credit of having first observed and described a pure skin disease caused by a yeast-like fungus."—Ricketts.

This case had really been observed before Busse's report, but it was not until after the latter that the organisms were positively identified as blastomycetes. Dr. Irwin Smith, of Washington, D. C. applied to the organism the name "Blastomyces dermatitidis." Then rapidly followed reports of cases by our American physicians and pathologists, Wells, Hessler, Hyde, Hektoen, Bevan, Coats, Baldwin, Brayton, Ricketts, and others. An excellent résumé of the early history of the disease and its organism is to be found in the memorial volume, "Contributions to Medical Science"—Ricketts, University of Chicago Press, 1911. It was at first considered solely a skin affection in this country and in only one of the twenty-six cases collected by Ricketts was it found elsewhere and that was in the lungs.

The most comprehensive discussion of generalized blastomycosis by several authors is contained in the Archives for Internal Medicine, 1914, in which Stober presents 29 cases collected from the literature, with invasion of the spine in 6, in the serial numbers 7, 8, 18, 19, 23, and 28, this being their order of succession in the generalized group. He summarizes this group as follows: The bodies were affected in all these except 23, in which the laminae were primarily affected. In two the spinal cord was affected, cases 18 and 23. It is more rapid and painful than Pott's disease. The duration is from four months to two years. In the majority of cases infection occurred in the lungs. The mortality was 90%.

As I have records of but seven cases besides the one just reported, a brief résumé of this number is given.

Summary of cases.

No. 7, 1905. Eisendraht and Ormsby. Male, aged 23 years. Blastomyces were found in the sputum. Died later after developing a dorsal kyphos.

Autopsy by Dr. LeCount, from whom we quote, "Kyphos at 4th dorsal vertebra, abscess between the pleurae. The anterior surface of the 2nd dorsal vertebra is the seat of a shallow erosion occupying the entire surface. The anterior half of the body of the 3rd, the entire body of the 4th, and the posterior half of the body of the 5th dorsal vertebrae are absent. There are found only a few fragments of the 4th, namely, the spinous and the articular processes. The cartilages on either side of the 4th are absent.

No. 8, 1904. Bassoe, from Senn's service, Presbyterian Hospital, boy, aged 17. "Blastomycotic caries of the 4th and 5th lumbar vertebrae." Organism found in pus and in the sputum. This was the first spinal case demonstrated at autopsy.

No. 18. Oswald, Patient a man in Alexian Brothers Hospital. Autopsy by Dr. W. A. Evans, who reported "several vertebrae were practically destroyed, together with the cord."

No. 19. Krost, Stober, Moes, Iowa. Man, aged 42 years. Abscesses of the back "exposed the 7th and 11th ribs, and the 9th, 10th, 11th, and 12th thoracic, and the 1st lumbar vertebrae, the spine of the 9th being almost completely eroded, the others showing only slight involvement." Many abscesses were present elsewhere.

No. 23, 1907. Boughton and Clark, Service of Dr. Ryerson. Male, aged 21, at Cook County Hospital.

"A kyphos at the level of the 2nd dorsal vertebra was noticed at this time." Diagnosis of tuberculosis of the lungs and spine was made. Three weeks later the patient became totally paralyzed. Sensation was diminished in the legs but was never completely lost. The knee jerks were increased; ankle clonus and Babinski's sign also were present. The diagnosis was changed in the presence of cutaneous lesions, and the organisms were found in the sputum and in the pus. The kyphos became more marked and death ensued. The post mortem disclosed "Kyphosis of the last cervical and the first dorsal vertebrae. This was covered by a large abscess. Manipulation of the first dorsal spine elicited distinct crepitus. Examination of the spine incomplete and no other part found affected."

No. 28, 1909. Eisendraht and Boughton, Cook County Hospital. Service of Dr. Ormsby. Male, aged 19 years.

Generalized infection. At autopsy the right side of the body of the 4th lumbar vertebra was found somewhat roughened. Chiseling into it, an abscess cavity was encountered which occupied about one-third of the body. The 3rd and 5th vertebrae were normal.

In the preceding collection I am not able to distinguish the case of Irons and Graham in the Presbyterian Hospital in 1905, with autopsy by Dr. LeCount.

The patient was 47 years old. Besides many cutaneous lesions, the post mortem record includes a "Retropharyngeal abscess with erosion of the bodies of the 7th cervical to the 5th dorsal inclusive and the anterior surfaces of the vertebral extremities of the 2nd and the 5th ribs." No vertebral symtoms were present. Blastomyces were found in the sputum. This makes seven cases exclusive of the one reported by the author.

Montgomery, in 1917, made a very exhaustive review of all obtainable cases of generalized blastomycosis and collected 44 cases, among which 9 were given of the vertebrae. These doubtlessly contained the six cases reported by Stober and the case by Irons and Graham, but I am unable to trace the others as their sources were not given. The lungs were affected 42 times, spleen, 18; liver, 11; kidney, 12; other bones 16 times. His percentage of vertebral incidence was 20.4%, a very considerable proportion.

His article is the latest compilation and I have been unable to find any more spinal cases in the literature up to the present.

As in actinomycosis, so probably in blastomycosis, some spinal cases that do not come to autopsy are not recognized, but as the total number of generalized cases reported up to the time of Montgomery's compilation was but 44, and the reports of further cases have been very meagre since then, it is evident that not so many are overlooked, as must be the case in actinomycosis, even if not all are diagnosed before death.

Diagnosis.

In Eisendraht and Ormsby's case the patient died after developing a dorsal kyphos.

In the Boughton, Clark, Ryerson case the history distinctly states, "A kyphos at the level of the 3rd dorsal vertebra was noticed at this time." Later "the kyphos became more marked." This was accompanied by complete motor paralysis.

In the author's case there was no definite kyphos, as the patient lay on his back continually during latter part of his illness. With the evident destruction of the 4th thoracic vertebra it would doubtlessly have shown had the patient been set upright. This gives two cases with distinct spinal deformities and a third with potential deformity.

As stated in Stober's statistics and experienced in the author's case, continuous and severe pain is the rule. This is not long relieved by reclining or other orthopaedic measures for overcoming gravity and pressure. It is the pain of malignant disease.

The favorite site of attack is the bodies, whence it extends into the pedicles, laminae, transverse and spinous process, and on to the ribs, a picture practically unknown in tuberculosis.

The presence of spinal symptoms in a frank case of recognized blastomycosis should readily suggest the character of the spinal infection and lead to the use of similar diagnostic measures to those mentioned in actinomycosis.

The presence of spinal symptoms in a patient suffering from an undetermined generalized infection or rare skin lesions should lead to an investigation of the accessible lesions in an effort to solve the spinal one.

In the hidden case, like the author's, with no external or general lesions, except those in the lungs, just the possibility of blastomycosis should be kept in mind.

The x-ray will be an important factor in the diagnosis. Regarding the x-ray appearance, Potter says, "The primary constant finding in the active lesion in bone is that of a localized dissolution. So intense and well defined is this process that it results in the peculiar condition in which centers of completely dissolved bone lie immediately adjacent to spongy bone tissue entirely intact." The affected bones, however, do not show the same diffuse porosis and general decalification as in tuberculosis, but are more patchy in appearance." Sequestrated bone has not been observed radiographically except in the form of detached fragments of spongy material resembling the fringe lining a cavity."

Lesions of the spine show the same patchy appearances that are found in the short bones of the wrist. A marked destruction of the vertebral bodies may take place before a collapse of their substance occurs.

This description fits very well the appearance observed in actinomycosis of the spine, with multiple separate and confluent foci and little tendency to lose the general form of the bodies.

Treatment.

The orthopaedic treatment, as in actinomycosis, is likely to be futile, as the spinal infection is also a secondary one and the primary condition may be far advanced before the spine is invaded. Measures suggested for actinomycosis are indicated here, and similar general measures may be employed.

Prognosis.

As all the spinal cases reported have come to autopsy because of their infection, their mortality is 100%.

Here also, earlier recognition and the development of newer methods of treatment may eventually give a more hopeful outlook

SUMMARY.

It is thus evident that in dealing with actinomycosis and blastomycosis of the spine we are dealing with an extremely malignant condition, with all the dis-

tressing features incident thereto, and before which we are today practically powerless. Yet, as they are both infectious processes instead of biologic perversions, there is a reasonable hope that their baneful effects will eventually come more or less completely under our control.

Note.

In the immediate future we shall have to consider oidomycosis of the spine, as Dickson, of San Francisco, in 1915, reported one case in California in a Hindu laborer, 26 years old. The post-mortem revealed "marked destruction of the bodies of the lumbar vertebrae." The infecting organism was oidium coccidoides. A young man suffering from this disease in Chicago, imported from California, recently had his second foot amputated for this disease. The spine has so far apparently escaped.

TREATMENT OF OBSTETRIC BRACHIAL PARALYSIS WITH A REPORT OF FIFTY CASES*.

BY SAMUEL W. BOORSTEIN, M. D., F. A. C. S., NEW YORK CITY.

The great interest recently shown in obstetric paralysis is due to the excellent work of Sever[13, 14]. Before him, considerable work was done by Kenedy, Clarke, Taylor and Prout[6], Fairbank[8] and Platt[12], but the profession at large was somewhat indifferent to this malady. Ehrenfest[7] in his monograph on Birth Injuries puts this state of affairs in proper light by stating: "Exact information concerning this phenomenon (in the newborn) is deplorably defective on account of the evident lack of interest of the obstetrician in the problem, which indifference in turn prevents the orthopaedist from seeing these palsies in the very early stage."

The family physicians in general not only gave a poor prognosis to the unfortunate parents, but did not even take the trouble to submit the patient to a more thorough examination by those qualified to do so. They were uncertain as to the proper treatments and usually, on their own accord, ordered massage and exercises to be given by the parents, and added, perhaps, the ever-abused electrical treatments.

It was Taylor who aroused the interest of the profession to the proper etiology and the prospects of improvement following nerve suture. His advice has not been followed extensively because of the natural reluctance of the public to submit to operations, especially in the case of infants. Fairbank in England and Sever in this country have again aroused the profession. They have emphasized the improvement that we can obtain by orthopaedic treatment, and, as a result of that, these patients are brought at present to the men best qualified to treat such cases, viz., the orthopaedic surgeons. The large number treated by the orthopaedic surgeons at present, as for instance, the eight hundred cases of Sever, proves that these cases are prevalent but were never brought to the surgeon's attention.

The cause of future treatment may be influenced by the controversies occurring in the methods of observation and conclusions deduced. It is, therefore, of paramount importance to report the results, and where the opportunities offer themselves to help clear up the difficulties.

* From the First Surgical Division of Fordham Hospital, New York.

While the group here reported is small in comparison to the number of cases reported by Taylor[17] and Sever[13], I feel, however, that I am in a particularly favorable position to compare some of the different methods, for the reason that I had the good fortune to assist Dr. Taylor in doing nerve suture operations on some of the cases. Some of these cases were under my observation for considerable periods before and after the operation.

In the Fifteenth Report of Progress in Orthopaedic Surgery prepared by Dr. Osgood and his coworkers it is stated: "Taylor still believes in operation on the brachial plexus in most cases of obstetric paralysis, since recoveries, as a whole, have been so unsatisfactory. He thinks the best time for this operation is at about three months." Some of Taylor's deductions have been misunderstood, while Taylor himself has changed the time of operation. It may, therefore, interest the members of this Association to get a report of some of the conclusions based on this work. I do not believe I shall lay myself open to criticism as being biased. In my training I am naturally inclined to orthopaedic methods, but medical interest requires that Dr. Taylor's advice be better understood. I am almost sure that in suitable cases these methods will then be followed. Perhaps more suitable cases will then be found to be operated on.

ETIOLOGY.

Here is not the place to discuss the etiology in detail, but in order to understand the work better, I have to remind you that it has been proven beyond any trace of doubt that the correct theory is the "traction theory," i. e., the damage is done by stretching of nerves of the brachial plexus by forcible separation of the head from one shoulder during delivery, or by direct traction on the arm (stretching, of course, may often result in complete tear of the nerve fibers). The work of Taylor[17,18], Sever[13,14], Fairbank[9] and Platt[12] has established this theory. In a few of the cases reported in a previous paper and in some additional cases reported below the damage to the nerves was distinctly found.

There is no need to mention the fallacious theory of T. T. Thomas[21,22] of congenital subluxation, as well as the theory of Weil[7] that often there is a truly congenital defect of development of the plexus as the result of continued mal attitude of the shoulders during intra-uterine life.

Fairbank[9] summarizes the conclusions about the theories briefly as follows:

"Although the occasional presence of definite adhesions in the joint in young infants suffering from birth palsy strongly suggests damage to the joint in these particular cases, I believe the traction theory best explains

the condition present in the vast majority of the cases and that the subluxation of the shoulder joint develops gradually and as a direct result of the paralysis. I hold this view for the following reasons:

"1. Tenderness and thickening over the plexus in the neck has been noted soon after birth in some cases.

"2. The almost constant finding of definite injury, sometimes amounting to complete rupture, of one or more nerve bundles of the plexus during operation. Those most likely to be damaged by separation of head and shoulder, viz.: fifth and sixth cervical, are the ones most found to be paralyzed.

"3. Experimental evidence that traction can produce tearing of these nerves, and that damage to the shoulder joint is extremely difficult to produce, fracture of the humerus or separation of its upper epiphysis occuring first. (Clarke, Taylor and Prout, Thomas and Sever, T. T. Thomas and Stone.)

"4. Taylor actually felt the plexus tear during delivery of a child, and the lesion was proved post mortem.

"5. Subluxation of the joint is rarely seen at birth, but its gradual development and fixation can be traced through cases of increasing age, the subluxation at first being reducible and becoming irreducible later."

About the mechanism of the force producing the injury at birth I will quote Ehrenfest[7]:

"1. The plexus is occasionally injured by the forceps and (2) possibly more often traumatized by a finger during improperly executed traction in the delivery of the aftercoming head. (3) Cervical nerve fibers under special mechanical conditions are injured by compression between clavicle and underlying bone structures, both in vertex and breech labors, and (4) probably less often are actually lacerated by excessive traction."

About the absence of congenital dislocation of the shoulder, Taylor[18] proved in his recent article on "So Called Congenital Dislocation of the Shoulder, Posterior Subluxation" that (1) there is no case on record where in a birth palsy case a posterior subluxation of the shoulder has been found at birth.

(2) No dislocation present up to six weeks of age. The dislocation at that time is sequel to the paralysis.

(3) The posterior dislocation is a sequel to the unbalanced paralysis of the shoulder muscles, and may be prevented in most cases by proper treatment. (Orthopaedic.)

(4) The external rotators (posterior muscles) suffer the most complete paralysis, and are continuously overstretched by the internal rotators, which

are usually not completely paralyzed and eventually develop organic contracture, with the result that the head of the humerus is gradually displaced backward.

SYMPTOMS.

The symptoms of this disease are well known and we will only recall to your mind the deformities present.

In the upper arm type: The arm hangs vertically in full internal rotation and adducted, and with the forearm pronated and the palm looking outwards and the fingers usually clenched, the so-called "policeman's tip position." The muscles chiefly affected: Supraspinatus and infraspinatus, deltoid, biceps, coracobrachialis, brachialis anticus, supinator longus and brevis and teres minor, i.e., the abductors and external rotators of the shoulder, flexors of elbow, and supinators of the forearm, and sometimes the radial extensors of the wrist. The serratus magnus is not uncommonly affected to a considerable extent. The injury to the plexus is located at about the junction of the fifth and sixth cervical nerve roots, just about the points of origin of the suprascapular nerve (Erb's point).

In the whole arm type (called by some lower arm type) all these conditions are found, besides the additional ones due to the paralytic conditions of the lower arm and hand, resulting generally in a useless dangle arm. There is usually wrist drop, paralysis of the flexors and extensors of the wrist and fingers, associated with paralysis and atrophy of the intrinsic muscles of the hand.

The injuries are mainly to the whole of the plexus, or at least the seventh and eighth cervical and the first dorsal roots.

There are rare cases involving the lower roots only, without the upper, (Klumpke's paralysis).

TREATMENT.

Prevention.—As most of the cases are due to delivery, Ehrenfest gives a proper warning to the obstetricians, advising special care in the application of forceps, and emphasizes the methods of managing the shoulders as follows: "In Mauricean-Smellie maneuver, the tips of index and middle fingers should be forked above the shoulders, not on the sides of the neck, but on the sternum of the infant." He advises that obstetricians with short fingers should keep the ends of these two fingers in extension and not flexed, as would be their more natural attitude in the attempt to pull on the shoulders. If severe traction is necessary, it should be made along the long axis of the child and never against or on the head in lateral flexion.

EARLY TREATMENT.

If the child is brought early to the orthopaedic surgeon, one of three methods is usually followed: (1) Retention in braces or a plaster cast followed by careful exercises. (2) Careful exercises (muscle training) alone without some retention apparatus. (3) Operative, viz., end to end suture of the injured nerves.

(1) Retention in plaster cast or braces.—In order to prevent contraction of unparalyzed muscles, it seems best to put the arm at rest in such a position that the stronger muscles can not contract. The arm is, therefore, put up in right angle abduction and full external rotation of the shoulder, the elbow is flexed at a right angle, forearm in full supination and, if necessary, dorsiflexion of the wrist. I am accustomed to leave the first plaster undisturbed for two or three weeks. Then the arm is taken down twice daily for massage and exercises. The plaster is made for a removable one and reapplied after the exercises. If the arm is kept in the support between massage and gymnastic treatments, one obtains a better subsequent position of the arm. It also takes the drag off the paralyzed shoulder muscles, particularly the deltoid, allowing them to regain their strength more quickly, and prevents subsequent shoulder deformity, such as posterior dislocation and acromion hooking and overgrowth. As the child improves, the plaster is left off gradually. Fairbank and Platt are consistent in using immobilization and retention. Platt even says, "I have little doubt that if this were adopted in every case there would be few cases which show no recovery of the paralytic phenomena, and no case would develop the internal rotation, contracture and posterior subluxation of the shoulder joint."

Sever[13,14] in his early articles strongly urged this method but in a paper recently delivered before the orthopaedic section of the New York Academy of Medicine, he said that he does not put up the affected limb in plaster or braces but depends entirely on proper exercises. The reason given by him is that the child forgets the use of the hand.

My experience has been the same as Fairbank's[9]; that the use of the support is of distinctly more advantage than it left off. Several cases of my series have convinced me of the advisability of proper and early support. I remember a number of patients who had no deformity when in the support but whose parents took off the support too early and, while apparently carrying out the exercises regularly, the deformity returned, or rather has not entirely been avoided. Of course, one has to watch for stiffness following the long immobilization, (See Case 29) but watching against deformity is the supreme duty of the orthopaedic surgeon and he can easily guard against adhesions. However, my experience is not as extensive as that of Dr. Sever.

About exercises: Those advocated by J. J. Thomas[19] of Boston seem to answer the purpose well. Lately at the Children's Hospital of Boston, Dr. Sever added the novelty of rhymes to the exercises, thus making it perhaps interesting for the infants. It is a form of occupational therapy that is worth while using. (We may have to give music lessons to our masseuses to have them administer the exercises.)

I also made use of some of the exercises advocated by Steindler[15] in his article "Muscle Educational Treatment and Results in Orthopaedic Work on Upper Extremity."

One must emphasize the fact that exercises or muscle training should be kept up for a very long time, perhaps till the child is ten years of age.

EARLY NERVE OPERATION.

Taylor's Method of Nerve Suture.—Taylor, following his careful observation with Clarke and Prout, advised early repair of nerve injury. He published many articles and showed his results. Some surgeons still doubt whether it is advisable to operate. They maintain that the result is not better than without the operation. Sever emphatically denies the advisability of that operation.

Fairbank[9], on the contrary, says:

"At what age should exploration upon the plexus be undertaken? If a case has been treated from the first, and after three months there is no sign of recovery by physical examination and electrical tests under an anaesthetic, I think operation is advisable. Many surgeons consider three months too early. The age favored by writers on this subject varies from two to twelve months. I am convinced that, in most, recovery is well advanced by the age of three months, and I think that rarely are the recognizable signs of recovery delayed beyond this period."

Taylor[17] in his latest article states: "The small minority of cases that do recover spontaneously are almost completely well at the end of three months. In cases which are obviously mild at the start one may expect a spontaneous recovery which will be nearly complete by the end of three months. Therefore operation is not indicated. In the more serious group in which almost the entire musculature of the extremity is primarily paralyzed and the lower roots show no tendency to spontaneous recovery in the first few days, it is practically certain that a permanent lesion has occurred, at least in the upper one or two roots, and early operation is indicated. Naturally, in the still severer types of injury, early operation is indicated without question. In the border line cases, operation is more debatable and

one must choose between early exploration and delay for three months to see what degree of spontaneous recovery will ensue. . . In all cases, whether operation is to be considered or not, the extremity should receive systematic attention. It is of primary importance to retain the extremity in a position which relaxes the paralyzed groups of muscles. . . This position may be retained by use of a brace such as is used by orthopaedic surgeons in deltoid paralysis. . . "

In a personal communication, Taylor gave me a short résumé of his views about the advisability of operating on these cases. I am quoting him exactly.

"Inasmuch as deformities can be prevented by proper postural treatment, and inasmuch as nerves will regenerate even though many months have passed since injury, one may wait safely for a considerable period of time, provided correct treatment is followed during that interval. If sufficient recovery has occurred during the first three months to justify the hope of almost complete spontaneous recovery, then it is legitimate to follow the case along with physical therapy. If, on the other hand, improvement at three months has been unsatisfactory, then, other things being equal, it is wise to do an exploration of the plexus. If there is damage which would not have recovered spontaneously, then the lesion can be repaired at once. If, by chance, the plexus is found not so involved as to demand surgical repair, the wound, which is practically only a skin incision, can be closed and the child's risk has been practically nothing. The advantage of this method is that without material risk one knows early in the case just what he is dealing with and if surgical repair is necessary it is done at the time which gives the greatest promise of favorable results."

The disadvantages of operation in very early infancy lie in the very small field and small nerves which make the technical part of the suture more difficult. On the other hand, the dissection is easier because the cicatricial tissue has not become so dense.

Are the results of operation better than these treated by orthopaedic methods alone? Cases 3, 23, 25 of my group, as well as other cases, prove that the operation is of distinct value if performed properly. One must, however, remember that the after treatments are of great importance. The operation is often discredited because the very severe cases showed no improvement at all.

When one watches the child from the start so that the deformities are prevented, the results following the operation are, of course, better. It is thus of paramount importance to guard against deformities, and, if present, to correct them by operative means before doing a nerve suture.

Method of Taylor's operation: "Oblique incision at the base of the neck from the posterior edge of insertion of sterno-cleido mastoid through skin, platysma and the underlying fat pad. When these are retracted the damaged nerves and adherent cicatrix are exposed. The various nerves are then dissected out and such repair work done as is found necessary."

LATE TREATMENT.

Correction of Deformities.—The most prominent deformity is at the shoulder, giving it adduction and internal rotation. If child is seen when the deformity is also present, it could be operated on by Sever's method of tenotomy of the contracted muscles.

When there is a hooking of the coracoid process, this could be corrected by a subperiosteal osteotomy. The acromion process often needs an osteotomy.

There is one deformity which is very persistent and that is the pronation of the forearm. For some reason the full supination is not attained. I have tried in many ways to prevent that but have not succeeded in all cases. In some I was fortunate enough to regain full power. This deformity can be corrected later on by an open tenotomy of the pronator radii teres.

Fig. 1.—Case 1.—Herbert A., Dec. 27, 1922—Showing extent of abduction of right arm. The elbow was kept in flexed position thus giving the impression that the arm is shorter. Note that there is no contraction of pectoralis major.

Fig. 2.—Case 1.—Herbert A., Dec. 27, 1922—Showing good power to rotate outward. This photograph shows that there is no shortening of the arm. Note the good muscular development and the excellent position of the wrist.

Fig. 3.—Case 1.—Herbert A., Dec. 27, 1922—Showing the extent of supination possible in the right hand.

Tubby suggests transforming the pronator radii teres into a supinator as follows: The pronator radii teres and flexor carpi radialis are defined and the tendon of the latter severed one and one half inches above the wrist. The pronator radii teres is put at full stretch and is joined to the proximal end of the flexor carpi radialis as low down as possible. The conjoined tendon is then pulled through the interosseous membrane, carried round the back of the radius and inserted on the outer side. A modification lately made by Tubby consists in a section at the same time of the interosseous membrane through its entire length. Sir Robert Jones is content to insert the pronator radii teres into the tendons of the extensor carpi radialis longus and brevis in order to destroy the power of pronation and strengthen dorsiflexion and correct ulnar deflection. One may transplant the muscle into the dorsal aspect of the radius.

If there is some rotation of the radius or ulna, an osteotomy has to be done.

Among the other operations used, one has to consider the stretching of the

Fig. 4.—Case 23.—Donald McC., Aug. 15, 1920—Before Treatment:—showing the typical position of adduction and inward rotation of the right arm. (Front View.)

Fig. 5.—Case 23.—Donald McC., Aug. 15, 1920—Before Treatment:—showing the typical "Policeman's tip position." (Back View.)

Fig. 6.—Case 23.—Donald McC., Aug. 15, 1920—Before Treatment:—showing power of abduction when the hand is supported on the wall.

Fig. 7.—Case 23.—Donald McC., Dec. 27, 1922—After Operation and Treatment:—showing power of abduction.

shoulder or elbow joint under deep anaesthesia and immobilization, but it is doubtful whether one obtains the desired results.

Report of a few cases to demonstrate certain features in the treatment.

Case No. 23.—Donald McC., male, age 8 years when first seen. History.—Child is the sixth in the family, instrumental delivery. Immediately after birth complete paralysis of right arm and forearm was noticed, with evidences of local trauma. Practically nothing was done for the child till seen by me on Aug. 12, 1920.

Physical Examination showed a well nourished and robust child. Right upper extremity held adducted and internally rotated with the elbow flexed to an angle of 160 degrees. Shoulder could not be abducted more than an angle of 5 degrees when he had to use the scapula. When patient lay on back, could abduct shoulder to an angle of 75 degrees. Outward rotation—markedly limited. Elbow flexed at an angle of 140 degrees. Can be flexed to an angle of 90 degrees. Forearm—pronated and could not be supinated. Wrist motion—fair. Finger motion—almost nil. Motor power of hand—right, 5 lbs.; left, 22 lbs. Slight atrophy of arm and forearm muscles. There was some asymmetry of the face. (Fig. 4, 5, 6.)

One can thus see that the nerves involved were probably CV, CVI, CVII, CVIII and DI.

Treatment.—Brace applied and massage and careful exercises begun. The boy is very intelligent and coöperated in every way. This course was followed for three months with very little improvement.

Patient was admitted to the First Surgical Division of Fordham Hospital and operated on by Dr. A. S. Taylor and myself on October 29, 1920. At the operation Sever's tenotomy was done, cutting only the pectoralis major. The shoulder was then released. There was hooking of the coracoid process and this was removed subperiosteally. The plexus was then exposed and the following condition found: fifth cervical and sixth cervical were torn off at the lower end of their junction, seventh cervical was torn off almost completely just where it inserted into the plexus, eighth cervical and first dorsal were not damaged but surrounded by heavy scar tissue.

Operation.—The distal ends of the nerves (fifth, sixth, and seventh cervical) dissected and end to end sutured with chromic cat gut. The scar

Fig. 8.—Case 23.—Donald McC., Dec. 27, 1922—After Operation and Treatments:—showing power of abduction when the elbow is flexed. Note ability to rotate arm outward.

Fig. 9.—Case 23.—Donald McC., Dec. 27, 1922—After Operation and Treatment:—showing power of supination of forearm.

tissue surrounding the eighth cervical and first dorsal removed and dissected freely the nerves.

After Treatments.—The hand was put back on the brace but the abduction was increased. Wound healed by first intention.

Nov. 20, 1920.—Began massage and exercises.

June, 1921.—Examination showed marked improvement. Brace discontinued.

Present Status (January 15, 1923).—(Which is the same as one year ago.) Patient can raise the shoulder to an angle of 110 degrees even when standing. If he desires to abduct the shoulder farther, he has to flex the elbow (showing therefore that there is contraction of biceps). Rotation outward—good. Extension of elbow—permitted to an angle of 120 degrees. Supination—limited. Wrist is slightly hyperextended. Finger motion—very much improved. (Fig. 7, 8, 9, 10).

Comment.—This patient illustrates that there was at birth distinct tear of 5th, 6th and 7th cervical and probably a tear of sheath of 8th cervical and 1st dorsal. He received orthopaedic treatment for a while but had not

improved enough. Since the nerve operation, the improvement has been marked. Would it not be better to operate at an earlier age than eight years?

One cannot attribute the entire improvement to the tenotomy, as the muscles supplied by the 7th and 8th cervical and 1st dorsal have shown marked improvement. The improvement in the deltoid is also marked.

January 19, 1923.—Patient was operated on by Dr. Taylor and myself at Fordham Hospital. An open tenotomy of the pronator radii teres was done. Forearm put in supination.

Case No. 25.—John S., male, age 6, when he came under my observation on November 11, 1920. No instrumental delivery. Complete paralysis of both upper extremities (whole). When the child was eighteen months old, a plexus operation on the right side was performed by a neurological surgeon. On June 4, 1921 a second operation was performed on the same side by the same surgeon. No after treatment was carried out. The result was nil. That discouraged the mother somewhat and she refused to have another

Fig. [illegible]—Case 23.—Donald McC., Dec. 27, 1922—After Operation and Treatment:—showing power in closing the fingers.

Fig. 11.—Case 25.—John S., Nov. 23, 1920—Before Treatment:—Note the position of both hands and the deformities.

operation on the left side, but used massage and exercises, with no improvement.

Patient examined by Dr. R. Sayre and myself on Nov. 11, 1920. Physical examination showed: Right hand—marked wrist drop, very little power to flex the fingers. Forearm kept pronated and could not be supinated. Elbow—extended, could not be flexed (due to a fracture of humerus). The head of the humerus was found anteriorly and an interval of 1/4 inch present between head of humerus and acromion process. No power in the deltoid, internal or external rotators. Slight power in the pectoralis major (as tested when child bends forward permitting the arms to drop). Marked wasting of the muscles of arm and forearm.

Left hand—wrist hyperextended. Very little power in the flexors of the fingers. Some power in the extensors of the fingers. Elbow in position of flexion at right angle and could not be extended. Could flex the elbow so that the forearm touched the arm throughout its entire extent. Forearm—pronated and could not be supinated. Shoulder—Head of humerus dislocated backward. No interval between head of humerus and coracoid process. Shoulder rotated inward. Patient could raise shoulder slightly (to an angle of 20 degrees) could not rotate it outward. Some power in the pectoralis

Fig. 12.—Case 25.—John S., Nov. 18, 1922—After Operation and Treatment:—Note ability to raise the left shoulder. The right hand was resting on a support.

Fig. 13.—Case 25.—John S., Nov. 18, 1922—After Operation and Treatment:—showing power of abduction in right arm and power of flexion in left elbow. Note hyperextension of wrist.

Fig. 14.—Case 25.—John S., Nov. 18, 1922—After Operation and Treatment:—showing power of extension of left elbow. The deformity in the arm is due to a fracture of humerus.

major (Fig. 11).

Treatment.—A double deltoid brace in the usual position applied and massage and regular muscle training ordered.

This treatment was faithfully continued till January, 1922, when it was decided to operate. The physical examination showed some improvement in both shoulders, particularly the left, but the improvement was not enough to permit him to use them to an appreciable extent. We believed that he had all the chances with the conservative treatment and therefore decided to operate.

He was operated on at the First Surgical Division of Fordham Hospital by Dr. A. S. Taylor and myself on Jan. 20, 1922.

At the operation the following was found: fifth cervical root torn apart with the two ends connected by scar tissue, 6th, 7th, and 8th cervical seemed to be in good condition. The 1st dorsal absent. A larger incision was made to find the peripheral end of the 1st dorsal but could not be found.

Treatment—The damaged portion of the 5th cervical was resected about one cm. and an end-to-end suture of chromic catgut passed through the good bundles and tied. Braces reapplied. After treatment carefully carried out.

He improved considerably. In June, 1922, he sustained a fracture of middle of left humerus which healed in time, though somewhat delayed.

Present examination, January, 1923, shows: *Left shoulder* when sitting—can raise to normal extent even without the brace; rotation outward better. Elbow flexed to an angle of 90 degrees and can be extended to an angle of 115 degrees; can be flexed to an angle of 45 degrees. Good power in the biceps. Forearm is supinated. Wrist is hyperextended. When the wrist is supported and kept in straight position can use the fingers fairly well even to feed himself. *Right shoulder*—Slight improvement but not as much as the left; can abduct the arm only to an angle of 10 degrees. Rotation—nil. Elbow is in position of extension. No power in the biceps. There is wrist drop. Forearm is pronated and marked deformity of radius present. (Fig. 12, 13 and 14.)

Operation on January 10, 1923 by Dr. Taylor and myself in Fordham Hospital. The right plexus was exposed and it was found that all fibers of the 5th, 6th, 7th and 8th cervical were of normal size and showed no evidence of tear. It is therefore evident that there was an avulsion of the nerves from the cord. An osteotomy was also done on the right radius, and forearm put in supination.

Comment.—This patient had a distinct injury to the nerves. The result of the first operation was not satisfactory, either through improper operation or through neglect of after treatment. He received conservative treatment for more than one year with very slight improvement. Following the plexus operation on the left side, however, with the same treatment, the improvement was marked. This was also a very bad case of whole arm paralysis in a child seven years of age. How much better would it have been to operate early, though some claim that there is no use in operating on severe cases.

Case No. 20.—Charles D., male, age 7. Came under my observation on May 8, 1920. Paralysis of right side (upper type) with marked contraction of the pectoralis major and teres major; can not abduct voluntarily the shoulder more than an angle of 25 degrees.

He was operated on May 10, 1920, on the First Surgical Division of Fordham Hospital by Dr. Taylor and myself. Sever's operation was done (tenotomy of the pectoralis major and subscapularis). The plexus was then exposed, and only two small neuromata over 5th and 6th cervical roots found; freed the fascia but no nerve suture performed. There was, therefore, distinct evidence of nerve injury.

Result.—Child has perfect use of the entire upper extremity. (Fig. 15 and 16.)

Fig. 15.—Case 20.—Charles D., Dec. 16, 1922—After Operation and Treatment.—showing good power of rotation outward and supination.

Fig. 16.—Case 20.—Charles D., Dec. 16, 1922—Showing good power of abduction after the operation and treatment.

Comment.—This case demonstrates the nerve injury but proves that the lack of motion was due to contraction of the pectoralis major and subscapularis. Had the child been treated properly from the beginning with orthopaedic measures, he would have made a perfect recovery, as the nerve regeneration was good.

Case No. 3.—William B., (This case was reported in my previous article from which I quote); male, came under my observation when six months old with right side whole arm paralysis. Treated by me for a short time by a brace, massage and exercises. Very little improvement resulted. Operated on by Dr. Taylor and myself at Fordham Hospital. Sever's operation performed, cutting the pectoralis major, teres major, and subscapularis. The brachial plexus was then exposed and the fifth and sixth roots were found seriously damaged, forming two masses connected by a narrow isthmus of connective tissue. The scar tissue was excised for a distance of 3 cm. until good nerve bundles were found. An end-to-end anastomosis was then done. Brace reapplied and after-treatment carefully carried out. The child made a perfect recovery with the exception of supination of forearm. He can not supinate it freely.

Comment.—This case demonstrates that the plexus was injuried extensively and would not have recovered by conservative treatment. Shows also the excellent result that one obtains from combination of Sever's and Taylor's operation at one sitting.

Case No. 1.—(Reported before, but case has been kept under observation since that time). Herbert A., (Referred by Dr. Ballin) male, age 3 weeks when brought to me in 1918 with right sided whole arm paralysis. Treated with a plaster cast. Made a complete recovery in one and one half years, with the exception of supination. Though he cannot supinate the forearm completely, he can use the hand to eat and write. (Fig. 1, 2, and 3.)

Comment.—This patient demonstrates that with proper orthopaedic treatment, viz., support and muscle training, one can obtain perfect result, with the exception of supination. I have had several cases in which in spite of excellent orthopaedic treatment, the full supination could never be obtained. This is probably due to inability to hold the forearm in good position. I have tried different devices in the plaster and the brace but so far have not perfected a method to prevent the deformity.

Case No. 32.—Sydney S., male, brought to me at the age of three weeks with upper arm paralysis. There was marked tenderness at the shoulder. A plaster cast was applied, which was changed after three months to a brace. Patient made a good recovery, but there were adhesions at the shoulder joint, thus giving him a prominent scapula. The adhesions had slowly to be broken up and then the full use was obtained.

Comment.—This case demonstrates that adhesions may occur in cases due to injury of the capsule. This can easily be foretold by the marked tenderness directly at the joint. The adhesions must be guarded against. I have had a few cases similar to this.

Case No. 27.—Alvin A., (Referred by Dr. Rubinstein) male, whole arm paralysis. Distinct history of impacted shoulder. Was seen by me at the age of four weeks. Put in a plaster cast for two and a half weeks; then instituted the usual treatment. After treating the child for two months found that the child kept the arm continuously in an abducted position (about 90 degrees with torso), due to adhesions formed. It took about four months before the shoulder was loose. Child made a perfect recovery.

Comment.—The adhesions in this case were evidently due to the injury of the capsule at birth and to the fact that I kept it in the abducted position for a long time to prevent stretching of the muscles. This case is reported as a warning to guard against adhesions where there is evidence of injury to the capsule. It also shows the inadvisability of keeping such cases in the abducted position without bringing the arm to adduction more frequently after the first two weeks.

Case No. 29.—Martin F., (Referred by Dr. Lenetzka) male, brought to me at the age of two and a half months with the typical deformities. Child received up to that time electricity and massage.

Arm was put in plaster cast, which was kept on for three weeks, then changed for a brace. Massage and exercises instituted. After receiving treatment for three months, the deformities were corrected and patient had fair use of the limb. The parents then discontinued the brace of their own accord but continued the exercises used by me. The mother was an intelligent woman and carried out the exercises regularly. I have not seen the child for a full year. When seen by me again, I found exactly the same deformities as at the first examination, though the child had fair use of the muscles.

Comment.—This case brings out the fact that the plaster or brace will correct the deformity in early stages; but deformity will return if the support is not continued long enough. If no brace has been used from the beginning, it stands to reason that the deformities will develop in spite of proper exercises. I have had a few similar cases where I had prevented the deformities when I had a chance to see these children early, but if the plaster or brace was discontinued too soon, either through my own order or through the parents' neglect, some deformity, though not so severe as in the usual run of cases, resulted.

Case No. 17.—Robert C., (Referred by Dr. Clurman) male, age 7 weeks when he came under my observation. Whole arm paralysis of the right upper extremity. Deformities—evidence of hematoma and adhesions of the right sternocleido mastoid, shoulder abducted and internally rotated. There was distinct laxity of the shoulder joint. Dislocation of head backward. Elbow joint extended. Forearm pronated. Some power in the fingers.

A plaster cast applied and left on for three weeks, then treatment instituted. Child made a good recovery in one year. The only deficiency left is inability to supinate freely.

Comment.—This was a case where I suspected that a nerve operation would be necessary. However, with the proper treatment the result was very good.

CONCLUSIONS.

1. Obstetric brachial paralysis should be treated by the orthopaedic surgeon as early as possible.

2. If treated early and properly, one may expect in the mild cases a good recovery in three or four months.

3. The more severe cases will require about six or seven months for a complete recovery.

4. Nerve operations are indicated if no improvement results in four months.

5. If sufficient improvement is noticed in four months, one may wait for four months more.

6. The shoulder should be put immediately in a splint or brace to prevent stretching of the paralyzed muscles and contraction of the unopposed muscles.

7. The support must be kept up for a very long time, for about eight to nine months, as deformities may occur.

8. Adhesions may occur due to slight injuries of the capsule, but these can be prevented.

9. The only deformity that it is hard to prevent is the pronation of the forearm.

10. The posterior dislocation is a sequel to the unbalanced paralysis of the shoulder muscles and may be prevented in most cases by proper orthopaedic methods.

11. The obstetricians can prevent the condition in many cases by proper management of the shoulder.

12. Taylor's procedure seems to be the most suitable for the nerve operations.

13. After-treatment must be carefully carried out after Taylor's operation.

14. Sever's operation is the best for correction of the shoulder deformities.

15. Hooking of the coracoid process should be corrected by a subperiosteal resection.

16. Pronation should be corrected by a tenotomy of the pronator radii teres. One may also transplant that muscle to use it as a supinator.

I wish to thank Dr. Alexander Nicoll, the Surgical Director of the First Surgical Division of Fordham Hospital, for his esteemed cooperation; and Dr. A. S. Taylor for his kind assistance and for personal help in this work.

TABLE NO. 1

Analysis of the fifty patients (53 cases)

Boys	29
Girls	21
Right arm affected	32
Left arm affected	15
Both arms	3
Upper arm type	23
Lower arm type	24
Both upper arm type	1
Both lower arm type	2
Total	50
History of normal delivery	12
History of difficult labor	15
History of forceps	18
Unknown	5
Total	50
Head Presentation	43
Breech Presentation	7
Total	50

TABLE NO. 2

Results of Treatments

No. patients who had no treatment before coming to me	23
No. patients who received improper treatment	6
No. patients who received incomplete orthopaedic treatment	9
No. patients who received proper orthopaedic treatment	12

TABLE NO. 3

Results in Relation to Deformities

	mark. def.	mod. def.	slight	none
1. No treatment before coming	8	8	5	
2. Improper treatment	3	0	2	
3. Incomplete orthopaedic treatment	2	3	4	
4. Proper orthopaedic treatment		1	4	

TABLE NO. 4

Results of Cases Treated by Writer*

Of the fifty cases only 21 submitted to real treatment

Perfect Result	(95 plus)	9
Good Result	(80 ")	9
Fair Result	(60-70)	1
Poor		none
Unknown		2

* Results of proper orthopaedic treatment are based on a percentage basis giving Function 75%, contour and shape—25%.

TABLE NO. 5

Treatments used:

1. Plaster, 13.
2. Braces, 3.
3. Operation—

(a) Taylor's (performed by some other surgeon with complete failure)	3
(b) Taylor's operation performed by Taylor	2
(c) Sever's alone	1
(d) Sever's and Taylor's	4
(e) Stretching	1
(f) Tenotomy of pronator radii teres	1

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REPORT OF UNUSUAL GAS INFECTION, WITH COMPOUND FRACTURE AND BRIDGING OF NEW BONE WITHOUT BONE TRANSPLANT

LOUIS A. O. GODDU, M. D., BOSTON, MASS.

Patient, a young man nineteen years of age, had his left arm and right hand mangled in a rope machine, March 21, 1921. Was admitted to local hospital and attended by physician who made repair of the lacerated area under complete anaesthesia. Remained twenty-four hours in the hospital, and then was referred to the writer.

He presented himself in a very poor condition, temperature 103½, weak, exhausted, and in a great deal of pain. X-rays were immediately taken, and he was admitted to the hospital.

Patient was immediately etherized, all stitches released, multiple incisions made through and through, drainage given with four sets of tubes inserted, and Dakin's treatment instituted. The following day patient's temperature was much lower, upper arm swelling had decreased, and evidently at present the situation seemed under control.

The entire dorsal aspect of the forearm, an area of about six inches, was exposed down to the ulna. The wound was doing well and temperature was normal. There was a very large amount of sloughing, and ruptured vessels could be seen. The tourniquet was kept by the bed, because of a possible chance of sloughing and consequent hemorrhage.

The problems presented were: First the saving of the boy's life, which was menaced by the gas infection; second, the saving of the arm, which apparently could be done; third, if the arm was saved, to make a useful member of it by the prevention of deformity and also of too much tying down of muscle and tendon by scar tissue. The dressing was changed every day under as aseptic conditions as possible.

Inasmuch as there was an absence of 3 inches of the radius, it was self-evident that even though the arm were healed there would be a loss of bone substance, and that bone graft could not be put on for some time because of the danger of lighting up the infection. Conservative measures were therefore advised.

PLATE NO. 1 AND NO. 2

There is a piece of radius missing, extending from a point about three inches above its lower end to a point about four inches higher. There is also evidence of gas bacillus infection in soft tissues, posterior to the injured radius. This area of gas infection includes about one-half inch of forearm and is evidently extending rapidly, as it has involved th's much of forearm in twenty-four hours.

(Signed) P. F. Butler.

PLATE NO. 3

X-Ray report shows the old injury of the radius to be now bridged across by a strong bridge of bone. This bridge is somewhat irregular in outline, but apparently composed of solid bone.

Massage and motion were begun long before the wounds were healed, and motions of the wrist and fingers were passively done each day. The patient was a foreigner and a rather difficult individual from whom to secure coöperation. He progressed well, and more and more as the fingers became of use, he was soon encouraged to use the hand and arm actively with the splint on. Granulations came along quickly, and patient was allowed to go about in order to keep him from becoming mentally depressed, and was encouraged to go to the theatre, which had a great value to keeping his general condition good.

April 24, 1921, patient was up and around, and out in the sunshine and doing well. Evidently at this time, as can be seen by the x-ray, there was no residual osteomyelitis of the ends of the radius. On May 6th a small bare piece of bone in the region of the ulna was removed, which had evidently prevented the healing, and Dakin's solution was started again in this region. The posterior aspect of the hand and the infiltration here as well as in the fingers caused considerable thickening of the soft tissue and consequently limitation of motion. Patient was given active exercises and massage. On June 9th he was getting more and more motion in his hand and fingers and was showing steady improvement; the condition was excellent. July 7th patient advised to go back to work as soon as some suitable work could be found.

X-ray taken August 23, 1921, shows the unusual bridging over of solid bone, which united the two ends of the radius. Clinically it was noticed that the patient could rotate the forearm, which he had not been able to do at any previous time.

He reported on March 2, 1922, and the only objection to the whole situation was that because of the slight amount of adduction of the hand at the wrist and the contraction during the period when there was loss of continuity in the radius, he had a deformity. The arm was very satisfactory and no further operative procedures were considered. On the whole the result may be considered excellent, and an unusual one in view of the type of infection and complications.

TREATMENT OF A CASE OF INTRACAPSULAR FRACTURE OF HIP BY WHITMAN METHOD

LOUIS A. O. GODDU, M. D., BOSTON, MASS.

In February, 1922, patient, who was walking across street, slipped on pavement and fell; felt something give in the hip. Was taken home and later sent to the hospital. X-ray taken showed intracapsular fracture of the left femur, with overriding about 1 inch. The writer deemed it advisable to try manipulation and reposition by the Whitman method. Patient was 56 years of age.

Figure No. 1 shows fracture before manipulation.

Figure No. 2, taken through the plaster, shows the hip after manipulation.

OPERATION:

Patient given full anaesthesia. Limb was forcibly adducted and traction made, attempt being made to bring the ends into such an apposition that upward pressure would not disassociate the position by actual measurement from the anterior superior spine to the intrainternal malleolus. Measurements made for length, and as both ends were the same, manipulation was stopped. Plaster cast applied, including the entire left limb, toes, foot, and hip, also the right leg to the knee. Patient was put on a Bradford frame, and turned each day. X-ray taken at the end of seven weeks showed the plaster still holding position, which was excellent. At the end of nine weeks, cast on the right limb was removed, and patient allowed up. After eleven weeks long cast removed and patient put in a short spica extending to the knee.

X ray (Fig. 3) taken at this time shows excellent position.

Inasmuch as these fractures give such poor results and prove so unsatisfactory, it was considered wise to carry out protective treatment for a longer period. The plaster was therefore bi-valved and removed at night; this kept on for two months.

August 18, 1922. Patient walking without crutches or any support and feeling no pain.

X ray (Fig. 4) shows the final result at this time.

Relative to the Whitman method in treating intracapsular fractures, this method is ideal if fractures are obtained early and coöperation be had in

FIG. 1

FIG. 2

FIG. 3

FIG. 4

treatment. The writer is likewise frank to say that perhaps many of the poor results may be attributed to the improper manipulations and retentive plaster. Extreme abduction is essential if one is certain that there is reposition of the fracture, and even though we do get absorption of the neck, there is a decrease due to the poor nutrition in this area because of the cutting off of the arteries of supply. We have at least the best means for a stable hip inasmuch as we have a good position. The writer feels that the support is taken away from these cases too quickly, and that it is not always possible to know definitely what sort of union exists and what part nature will take relative to a future process within the fractured area. It seems, therefore, perfectly rational that the hip should be protected with a plaster of Paris cast that can be bi-valved and removed at night so that the patient can carry on motion without weight bearing, and thus obviate any possible harm from too much function. The cast worn during the day allows the weight bearing without motion, and therefore a certain amount of function is permitted in the limb, i.e., weight bearing, which one must concede naturally tends to better nutrition of the part.

One might feel that this case showed an exceptionally good result, but in a perusal of the literature and from the writer's clinical observation it would seem that perhaps we have been prone to accept the treatment of these cases with an idea that the greater portion of the hips in patients past middle life do not unite, but the writer must come forth in stating that there certainly must be a lack of proper control of the case in the majority of these hips that do not apparently do well. The acceptance of the plea that we usually get an ununited fracture must be taken with a grain of salt, as we know, no matter where the fracture, if we do not have a fairly good apposition of the parts there is bound to be a deformity with a non-union or a faulty union, and this same principle should apply to intracapsular fractures of the hip.

It must be admitted that these cases are difficult, and can be properly handled only by adequate manipulation, retention, and careful checking up by x-rays. The fractures should be handled as soon after the accident as possible.

It would seem that the Whitman method certainly overshadows any other method of treatment of these hips in patients past middle age, as they can be turned easily, they are comfortable, and there is no fear of disassociation of the apposition of the fragments once they are in place and held by a proper plaster of Paris cast. One should bear in mind that there is no more disabling condition and disheartening to the patient himself than an ununited fracture of the hip or a hip with some union in a position of deformity, which gives constant pain, because the union is below the point of fracture and upper

portion of the femur, so that the region of the trochanter constantly impinges in the area about the acetabulum and ilium. This soon debilitates and discourages the patient to such an extent that he becomes an easy victim to intercurrent infections and is of no satisfaction to himself or others around him, and in the majority of cases can look forward only to a life of invalidism.

The following letter was received from the patient October 28, 1922.

"I am getting along fine. Going anywhere alone, up and down stairs the regular way, and excepting a lack of speed in some things go about my daily life much as usual. My prize achievement is tying my shoe. It is a bit difficult as yet, and somewhat a contortionist's feat, but I am so thankful to be able to do it at all, for now I am quite independent. I am not walking to suit myself yet, and I am quite sure you would frown if you saw me on the street. Maybe you will decide it is habit."

AN OPERATION FOR THE CORRECTION OF "DROP-FOOT."

BY WILLIS C. CAMPBELL, M. D., MEMPHIS, TENN.

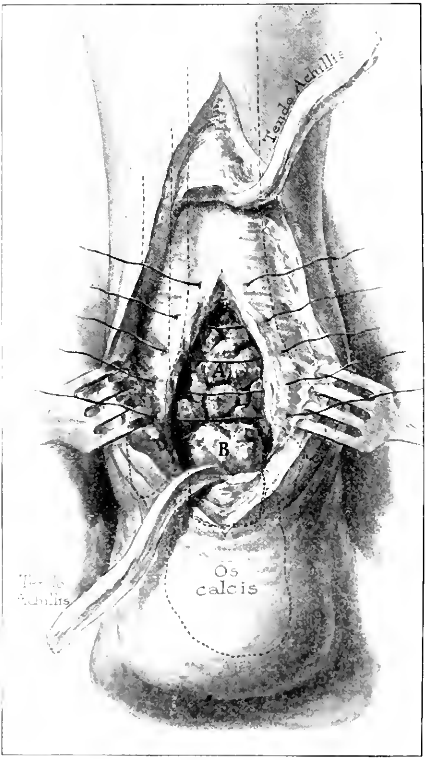
Paralysis of the anterior group of muscles of the leg causes an inability to voluntarily lift the foot or dorsiflex the ankle joint, the so called "drop-foot," which is a common disability and may be the sequela of lead poisoning, destruction of the external popliteal nerve, extensive loss of tendon and muscle, but more frequently the result of anterior poliomyelitis, infantile paralysis.

All operative procedures attempt to suspend the foot from the anterior aspect of the leg with silk ligaments, tendons, and fascia lata, but the results of such methods are uncertain and often disappointing, as the constant force of gravity of the pendulous foot causes elongation of the artifical ligaments and recurrence. Consequently, it is generally admitted that we have no satisfactory method by which permanent correction can be obtained. As stated by the Commission appointed by the American Orthopedic Association for the study of stabilizing operations on the foot, in speaking of drop-foot, "none of the operative methods considered can be confidently recommended as a standard procedure."

In September, 1918, I reported in the Journal of the American Medical Association an operation for the correction of genu recurvatum, which consisted in transferring and attaching the lower third of the posterior surface of the patella, after denuding of cartilage, to the anterior aspect of the tibia, the upper two-thirds extending above the articular surface of the tibia, thus limiting extension of the knee joint. From the principles of this procedure has been evolved a routine operation for the prevention of drop-foot, but attacking the problem from an entirely different angle, the posterior instead of the anterior aspect of the ankle joint. In a large per cent. of paralytic feet it is necessary to remove bone for the purpose of the correction of deformity and stabilization of the mid-tarsal region. These particles of spongy bone may be employed as transplants in order to block plantar flexion. A description of the operation may be better understood if divided into two parts, the technique of the first part is as follows:

An incision is made over the antero-lateral surface, beginning about one inch above the ankle joint, internal to and parallel with the fibula, passing downward to the external cuneiform bone. After division of deep fascia the extensor tendons are reflected inward, where the ligaments and periosteum are severed to bone, thus having easy access to the entire mid-tarsal region.

(This approach we employ as a routine for astragalectomy and practically all radical procedures for deformities of the feet). A small portion of the head of the astragalus is removed and the entire scaphoid bone, or a large portion thereof; the articular cartilage is excised from the posterior surfaces of the cuneiform bones. The calcaneo-cuboid joint is freely excised, and also the calcaneo-astragaloid, thus forming a triple arthrodesis. The scaphoid and particles of bone are placed in a sterile towel or pan and



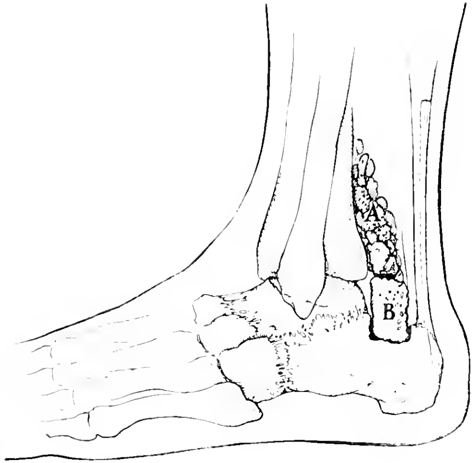
No. 1. Illustrating steps of the operation, showing "B" the scaphoid and "A" small particles of bone making a pyramidal mass.

carefully preserved. The raw bony surfaces are approximated and sutured together with chromic cat-gut, all layers are closed in routine manner. The object so far is to produce a stable foot and does not differ from the principle of Dunn, Davis, Ryerson, and others.

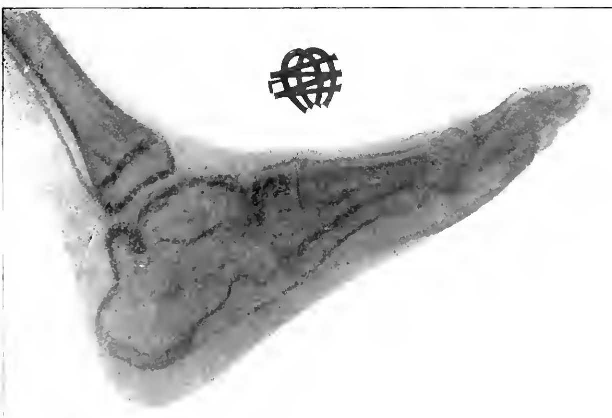
In many, however, a much less radical procedure may be instituted, depending on the indications of the individual case. The technique of the second part is as follows:

Attention by an assistant is next given to the excised bone. The scaphoid and all particles of bone are denuded of cartilage and fibrous tissue, producing one large oval mass and many small particles of spongy bone. A skin incision is now made over the tendo Achillis, and by common Z-plastic method, this structure is severed and reflected above and below. The loose fibrous and areolar tissue is incised in the mid-line and also the posterior

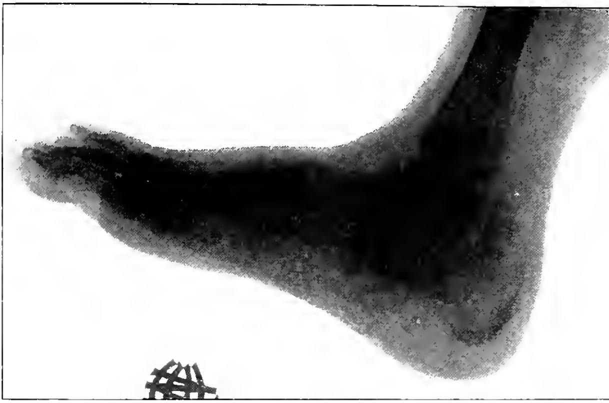
Typical "drop-foot" before operation.



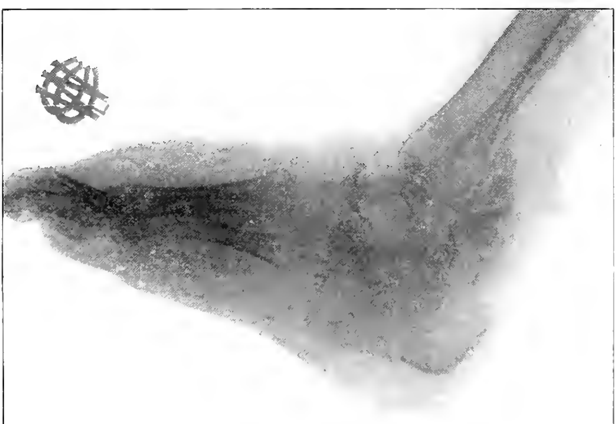
No. [illegible] (A) Small particles of spongy bone from the tarsal region. (B) Scaphoid bone grafted into os calcis making stop joint.



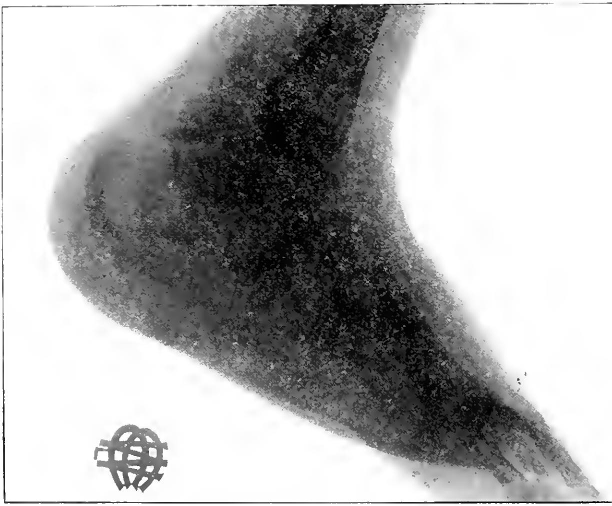
Showing small intra-articular block which has been used in a number of cases and seems to answer the purpose.



Showing anterior and posterior bone block.



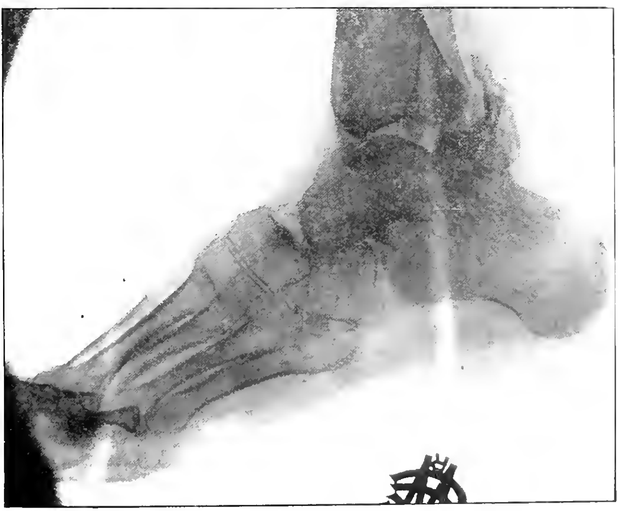
Six months after operation showing organization of fragments into concrete mass.



Six weeks after operation showing beginning fusion of fragments.

Three months after bone block operation.

Six months after bone block operation.



One year after operation showing callus completely organized into a new bone process continuous with and a part of the os calcis.

"Drop-foot" brace used in the after treatment.

Six months after tendon sling operation as described in the text.

One year after tendon sling operation as described in the text.

capsule of the ankle joint. With a large periosteal elevator a pyramidal space is cleared, exposing the posterior surface of the tibia, ankle joint, and the superior surface of the os calcis. The foot is dorsiflexed and the posterior extremity of the astragalus is removed. A wedged shaped cavity is made in the os calcis below the posterior extremity of the astragalus, into which the scaphoid is inserted and all the loose particles of spongy bone placed in a pyramidal mass, extending well over the posterior surface of the tibia. The soft parts are sutured snugly to retain the transplants in situ, the tendo Achillis united, fascia and skin closed. The foot is then retained at right angles with a plaster cast. Over correction is especially avoided, as it is preferable to have a slight degree of plantar flexion in order to avoid flat sole or heel walking. At the end of six or eight weeks the cast is removed and X Rays made, which always show definite proliferation. A sequence of radiograms exhibits a gradual organization of bone until there is a solid mass continuous with and forming a part of the os calcis, blocking plantar flexion, as the olecraneon process limits extension in the normal elbow.

In some of the cases associated with genu valgum a wedge of spongy bone has been secured from the lower extremity of the femur by open osteotomy. This presents an excellent subtitute in lieu of or in conjunction with the tarsal transplants when it is desirable to do less radical procedures on the foot.

On removal of the cast, an ankle brace is applied which consists of a single posterior bar and calf band, attached to the shoe by a bar inserted into the heel, having a drop-foot catch at the junction of the heel and single upright bar, which is of decided advantage from a cosmetic standpoint.

The scope of this operation has gradually increased, the procedence having been employed in various lateral deformities of the foot associated with drop-foot, or, whenever for the sake of stability it was decided to limit plantar flexion. The same principles are also applied to limit dorsal flexion.

Not infrequently drop-foot exists when the anterior group is only partially paralyzed and the dorsiflexors have distinct power, but not sufficient to elevate the foot in walking. In such cases, as an adjunct to the technique described above, the tendons of the peroneus parvus and extensor longus digitorum are severed as low as possible. A tunnel is made transverely through the cuneiform bones, through which the three outer tendons are passed from without inward and the two inner tendons from within outward, thus passing in opposite directions. The foot can be held in any desired position by traction on the ends of the severed tendons, which are stitched together in the midline over the superior surface of the cuneiform bones and to the periosteum. Formerly this method was employed without the bone block and in a limited number was fairly successful, but it did not stand the test of time. Associated however, with the operation for bone block there is no over-stretching, and restoration of function is a material and permanent gain.

The first case was operated on July 1, 1922, since which time the method has been employed in 24 cases. Sufficient time has not elapsed to make a statistical report, but from the evidence offered by the X Ray and clinical findings, in every one of the early cases, there is little doubt that the purpose and mechanical requirements have been definitely accomplished.

DISCUSSION OF DR. CAMPBELL'S PAPER

Dr. James Warren Sever, Boston, Mass.: I have been asked to open this discussion and I find that it is very easy to accept such an invitation but I have not the slightest idea what I am going to say.

I do not think Dr. Campbell has made it very clear, at least it is not to me, on what particular type of foot he does this very extensive operation. It seems to me that simple drop foot as we usually see it following infantile paralysis, with perhaps a moderate amount of weakness in the anterior tendons, can be easily taken care of by the Gallie method without doing any such extensive or radical operation as Dr. Campbell has described. The fascia transplantations have not been wholly unsuccessful. Fascia does not stretch, and the tendon which is inserted by the Gallie method does not stretch. A shortened tendon should not stretch. To shorten a weakened muscle by any method for holding the foot up will almost invariably give a relapse. To do such an extensive operation for drop foot, which not only shortens the foot to such a degree, but which involves one-half of the foot in a possible future distortion, seems wholly unnecessary. A foot that not only is short but which has a large amount of new bone growth which we cannot limit and in a location where motion occurs, seems to me may eventually be a very useless result. I do not know how long Dr. Campbell has followed the results. My only excuse for appearing at all is for the purpose of starting discussion and getting an idea from the gentlemen here as to whether they think such an extremely radical procedure is necessary. My opinion is that if a patient has a drop foot which requires such an operation, that either the Hoke method or the astragalectomy of Whitman is far superior.

Dr. John Ridlon, Chicago, Ill.: I want to say one word in the way of protest that any operation should be performed on such drop feet as those shown in these photographs until it has been demonstrated by long-continued and uninterrupted immobilization that there is not sufficient return in the anterior muscular strength to enable the patient to get along comfortably without any operation at all.

Dr. Armitage Whitman, New York City: The principle on which this operation was performed was described by a French author in the "Revue d' Orthopédie" several years ago. He accomplished his object by driving a bone peg through the astragalus into the fore part of the foot, leaving the posterior and projecting to act as a block against the posterior border of the lower extremity of the tibia. I also remember pointing out about three years ago to Dr. Cook a case we saw at Hartford in which the same thing had been accomplished by fracture of the astragalus. The patient, a woman, complained of no pain. She could plantar flex the foot to a right angle.

Dr. Charles A. Stone, St. Louis, Mo.: I would like to say that at the St. Louis Children's Hospital we have a considerable number of these drop feet that have been corrected by the method of Whitman, and they are to us very satisfactory.

Dr. Robert McE. Schauffler, Kansas City, Mo.: Dr. Campbell does not need to be defended; he is very well able to do that for himself. It seems to me he has been a little misunderstood in the discussion. He has a proposition to build up a pin on the back of the astragalus, a sort of odontoid process, a bony block. The Xrays show how successfully this has been done. It is not an arthrodesis. It is a finger block of bone sticking up behind like an odontoid process. In intractable cases of drop foot it is an ingenious method of preventing that drop foot, and one which ought to appeal to this Society.

Dr. A. H. Cilley, New York City: I do not see why we should take the scaphoid out of a simple drop foot.

Dr. Willis C. Campbell, Memphis, Tenn. (closing the discussion): As stated in my report, the Commission of the American Orthopedic Association, appointed to make a survey of various procedures, unanimously agreed, after carefully investigating different methods for the correction of "drop foot" that no known procedure gave satisfactory results. They furthermore stated that radical operative procedures on the skeletal system of the foot were essential to success in unstable paralytic feet, and this was the consensus of opinion of this Association.

Dr. Sever states that the method is too radical and recommends Royal Whitman's astragalectomy or Hoke's operation. Both are as radical as any method I have suggested. Hoke distinctly states that his operation does not attempt to correct "drop foot;" hence is irrelevant to the subject. There is nothing new in triple arthrodesis on the foot, which is frequently necessary for the purpose of fixation and stabilization of flail feet. The amount of bone removed differs as to the condition existing, but as it is usually necessary to remove bone in the tarsal region, one may thus obtain sufficient spongy bone for the purpose of mechanically producing bone bloc posterior to the ankle joint. We have, in some cases, when the foot was quite stable, obtained spongy bone from elsewhere; for instance, when genu valgum was coexistent, excess bone might be obtained from the lower end of the femur, or a wedged shaped piece might be taken from the trochanter or any convenient point where spongy bone may be found.

Dr. Armitage Whitman's description of a French method of grafting bone through the astragalus is in no way parallel to the procedure I have described. Besides, it has been clearly shown that grafts of dense bone, through joints, in children and animals, become absorbed; whereas, I have shown that the mutiple transplants of spongy bone proliferate and become fused to the oscalcis, causing a definite and permanent bloc.

Dr. Ridlon's contention is correct, but the operation is not offered until all measures for restoration of function have failed and a permanent residual paralysis exists.

Dr. Cilley asked why the scaphoid is removed. If ankylosis can be produced between the head of the astragalus and the cuneiform bone, a more stable foot is the result. The question of stabilization of the foot, however, is quite a different problem, my sole purpose being to point out a procedure for the correction of "drop foot." A complete statistical report of end results will be made after sufficient time elapses.

News Notes

The annual meeting of the British Orthopaedic Association will be held at Birmingham on October 19th and 20th.

At the Annual Meeting of the American Orthopaedic Association held in Rochester, New York, on June 7, 8, and 9, 1923, the following officers and committees were appointed:

President: William Stevenson Baer, Baltimore.

President-Elect: Edwin W. Ryerson, Chicago.

Vice-President: James T. Watkins, San Francisco.

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Book Reviews

Reconstructive Surgery of the Upper Extremity. By ARTHUR STEINDLER, M.D., F.A.C.S., Professor of Orthopaedic Surgery, Iowa State University Medical School. D. Appleton and Company. New York and London, 1923.

It has been a pleasure to review this book on reconstructive surgery of the upper extremity by a well known member of the American Orthopedic Association, Professor Arthur Steindler of the Iowa State University Medical School. We know of no book which covers so thoroughly this important subject. It is a subject to which the author has given special attention and to which he brings a fund of very wide experience and mature consideration. From the point of view of wage earning capacity, the function of the upper extremity is probably more important than that of the lower extremity, and any degree of improvement, therefore, which can be brought about by patient training and operative procedures becomes of greatest value. The book is illustrated by clear line drawings of the author's operative procedures and a wealth of personal photographs showing the results following the operative and non-operative methods which he has found to stand the test of time. A thoroughly efficient hospital and a fortunate State law which aid the surgeon very materially in following up his cases, coupled with Professor Steindler's marked ability, have made possible the collection and careful digestion of a vast amount of material which forms the basis of this book. There is much food for thought in its 300 pages, and the surgeon should be able, by their perusal, to reach sound conclusions as to methods of treatment and to give wise advice when he is consulted concerning reconstructive surgery of the upper extremity.

Anaesthetics in Practice and Theory. By J. BLOMFIELD, O.B.E., M.D. Senior Anaesthetist to St. George's Hospital and Lecturer on Anaesthetics to the Medical School. Chicago: Chicago Medical Book Company, 1923.

This is presented as a textbook for practitioners and students. As an introduction it describes in a comprehensive, necessarily brief manner, the development of anaesthesia from ancient and medieval to modern times, from the stages of narcosis and hypno-narcosis to inhalat'on and local administration. It touches briefly upon the various theories of the nature of anaesthesia, drawing upon the phenomena observed in vegetable and animal experimentation. The physical and chemical properties of the various general anaesthetics are considered in detail; likewise the methods of preparation and preservation, and the impurities which are to be guarded against. The physiological action of chloroform, ether, nitrous oxide, and ethyl chloride is carefully analyzed, with a brief discussion of the less frequently used agents.

About one third of the text is devoted to the induction of general anaethesia. Emphasis is laid mainly upon the administration of ether, nitrous oxide, chloroform, and ethyl chloride; to a lesser degree, of the minor agents and various mixtures. The author duly emphasizes the careful preparation of the patient and the proper environment. He describes in detail the technique of the various methods of administration and the apparatus which he believes most useful. The signs indicative of

a normal progress are minutely explained; likewise those indicating the intervention of undesirable conditions. The method of making a proper choice of an anaesthetic, as affected by the position and nature of the operation and the physical and mental condition of the patient, is fully discussed. Attention is given to preliminary drug therapy, to the cause and treatment of the accidents or other undesirable conditions that may complicate or follow anaesthesia. The unusual uses of anaesthesia are briefly noted.

A rather cursory attention is given to the technique of local, spinal, and sacral analgesia, the indications for, and scope of, their use, the various drugs available and the undesirable effects. Finally, the fatalities of anaesthesia are considered: their cause, frequency, and certain of their medico-legal aspects. A complete index of the text is appended.

This work constitutes a valuable contribution to the literature of anaesthesia. Its chief value lies in the mass of practical knowledge which the author has incorporated, the result of his own experience and keen observation. While it deals in an eminently readable manner with the theory, practice, and art of anaesthesia, it is not, and apparently is not intended to be, an exhaustive treatise. The main attention is focused upon general anaesthesia. Comparatively little space is devoted to local, regional, and spinal analgesia. Though sparingly illustrated, it gives an adequate picture of the apparatus which, in the author's opinion, is most useful. As a concise, easily accessible guide to general anaesthesia it will be found of very considerable value.

Foot Knowledge. By HERMAN W. MARSHALL, M.D. Boston: Boot and Shoe Recorder Publishing Company.

This contribution to topics of feet and shoes includes chapters that will be of interest to every orthopaedic surgeon.

There is a compilation of current notions about feet, based upon an unusually exhaustive questionnaire of fifty items. The set of questions was voted on and commented on by one hundred orthopaedic surgeons and thirty-five shoe dealers scattered throughout the United States.

Side by side, presenting different viewpoints, are opinions from conservative scientific men and progressive shoe men. Despite numerous interesting variations in opinion, there was, in the vote that was taken on the fifty statements submitted, 88% of agreement with the prepared list among orthopaedic surgeons and 82% of agreement among shoe dealers.

The writer states that the unique combined nature of tabulated results prevented their presentation to the medical profession through usual channels of strictly scientific journals.

The book presents interesting evidence, as to how far a progressive trade journal will go in attempting to enlighten its readers. There are nineteen very short chapters written in non-technical language, with numerous illustrations, describing fundamental medical ideas about shoes and feet. There are four chapters dealing with the author's personal experience in wearing various types of shoes.

Many readers will not agree with all of the author's statements and interpretations, but the text is fairly accurate and pictures are carefully selected. There are a number of minor mistakes which would not appear in a carefully prepared and strictly scientific publication; but these may well be forgiven when the fact is considered that the book is a pioneer trade publication.

Current Orthopaedic Literature

PARALYTIC CONDITIONS

AFTER CARE OF INFANTILE PARALYSIS CASES OF THE 1916 EPIDEMIC IN BROOKLYN. H. G. Dunham and Thomas J. Riley. *Journal A. M. A.*, January 27, 1923.

Attention is called to the large incidence of non-paralytic or abortive forms of infantile paralysis, especially to their importance as possible distributors of the disease. It is stated that this form is very common and probably afflicts a large proportion of the population in early life. The disease is said to be increasing and to be endemic in some parts of Europe. The abortive form is prone to go unrecognized. Seasonal relation is marked, a large percentage occurring in summer. Transmission by secretions of nose and throat has been demonstrated. The erratic susceptibility among those exposed may be due to natural immunity.

A significant finding in the epidemic report was that a large percentage of those affected had diseased noses and throats, while per contra, only a small group of patients previously operated upon for tonsils and adenoids contracted the disease, and in these the percentage of recoveries was much higher than in those who had not been operated upon. One attack confers immunity. The mortality in the epidemic was approximately twenty-five per cent. A majority of patients were under five years of age. The proper isolation period is two weeks.

The characteristics of the cerebro-spinal fluid during the attack are described. The fact is noted that poliomyelitis attacks both motor and sensory portions of the cord, but the motor side bears the brunt of the damage.

The severity of the onset bears no relation to the extent of the subsequent paralysis. There are no characteristic signs or symptoms, save the paralyses. Pain along spine, legs, and neck, fever and headache, a drowsy mental state, becoming irritable during manipulation, are frequent.

The character of the spinal fluid is suggested as the most valuable aid in clearing up the diagnosis before paralysis occurs. The isolation for a few days of all suspicious cases, particularly during an epidemic, is urgently necessary for prophylaxis.

As to the prognosis, it is stated that the younger the child, the nearer does restoration of function approximate the normal status.

All the cases reported were given massage and muscle training, which was most effective when given by trained operators. The lapse of a considerable length of time between the development of the disease and the beginning of treatment is no bar to improvement, even though deformities have occurred.

The most frequent combination of involvement in the series was back and lower abdomen with both lower extremities. The involvements of upper extremity did not

respond to treatment as readily as those of lower extremity. Exercise of muscles, pushed to the point of fatigue, is more harmful than no treatment.

The end results of the operative procedures carried out in this series are not commented upon, the time elapsed being considered too short.—*C. L. Lowman, M. D., Los Angeles, Calif.*

PARALYSIS OF THE SCAPULAR GIRDLE. E. Smeesters. *Arch. Franco-Belges de Chir.*, July, 1922, p. 951.

The case reported is that of a girl of 15, who had infantile paralysis at 2 years of age. The ultimate condition was a complete paralysis of all of the muscles of the right shoulder with the exception of the pectoralis major, infraspinatus, and trapezius, which were weak. The hand and forearm were good. The only movement of the right arm was adduction. The humerus was usually luxated anteriorly. At the operation the pectoralis was lengthened, the arm abducted, the anterior capsule reefed, and an attempt made to use the trapezius and infraspinatus as abductors. Six weeks later the patient was able to get some abduction and the result seemed to be good. However, eight days later subluxation occurred and could not be reduced, even under full anesthesia. Then arthrodesis was done. This was successful.—*J. Albert Key, M.D., Baltimore, Md.*

FRACTURES AND DISLOCATIONS.

A CASE OF POSTERIOR DISPLACEMENT OF THE SEVENTH CERVICAL VERTEBRA WITH ISOLATED ROOT COMPRESSION. J. Caheu. *Archiv. Franco-Belges de Chir.*, 1922, 25, No. 10, p. 945.

The case is that of a man of 53 who was injured in an automobile accident. Upon regaining consciousness six hours after the accident he was much agitated, very noisy, and complained of severe pain in the neck and arms. Two or three days later the arms were completely paralysed. Fifteen days later there was considerable atrophy of the right hand and marked formication and hyperesthesia. An X-ray showed a posterior displacement of the seventh cervical vertebra. Six months later there was some persistent paralysis and formication, more marked on the right. The diagnosis was not made until some months after the accident and then manual reduction was attempted, but was not successful. Open operation was refused. The patient became an invalid.—*J. Albert Key, M.D., Baltimore, Md.*

CONTRIBUTION TO THE STUDY OF THE DISLOCATION OF THE HEAD OF THE RADIUS WITHOUT FRACTURE OF THE ULNA. A. Contargyris. *La Grèce Médicale*, March-April, 1922, p. 9.

In this article the author gives a general outline of the lesion, considering history, pathology, symptoms, diagnosis, and therapy. He reports two cases which he presented before the Medico-Surgical Society of Athens.

Case 1. A soldier, 28 years of age, with a forward dislocation of the head of the left radius, without fracture of the left ulna, caused by one of his comrades falling on the posterior surface of his outstretched left arm. Although reposition of the head of the radius was not secured, the soldier, six months later, presented no functional disability.

Case 2. Soldier, 22 years of age, with outward dislocation of the head of the left radius, caused by a fall upon the left elbow, with the forearm in flexion and forced pronation. Ulna not fractured. Reposition was not secured, but one year after the accident there was no complaint of serious functional difficulty.

The author concludes that this dislocation is not as rare as was formerly supposed and that the prognosis is good.

In regard to treatment, the author favors the use of hot baths and massage, reserving open operation solely for the cases where failure to replace the head of the radius causes serious functional disability.

LATERAL SUBLUXATION OF THE THIRD CERVICAL VERTEBRA ON THE FOURTH. Gruget. *Arch. Franco-Belges de Chir.*, July, 1922, 25, No. 10, p. 939.

The case reported is that of a young man of 20, who fell a distance of about 5 metres, striking his head. He fainted. When he became conscious he had no great pain, but bystanders said that his head was crosswise. The next day there was severe torticollis and all the movements of the head and left shoulder and arm were limited and painful. Eight days later he came to the clinic with head inclined to left and rotated to right and the left shoulder raised. There was marked tenderness at the level of the upper four cervical vertebrae. An X-ray showed the third cervical vertebra displaced laterally upon the fourth. The patient was placed in bed with head traction of 5 kilos. On the fourth day the deviation was less pronounced, and without anesthesia reduction was accomplished by extension, flexion, and rotation. There was no perceptible snap. Three months later there was no trace of the accident.—*J. Albert Key, M.D., Baltimore, Md.*

THE OPTIMUM TIME FOR OSTEOSYNTHESIS IN FRACTURES. A. Lambotte. *Archiv. Franco-Belges de Chir.*, 26, 57, Jan., 1923.

The author states that for some years past he has maintained that osteosynthesis, if performed at the proper time, hastens rather than retards consolidation in fractures. In simple fractures of the femur or ankle in adults he recommends waiting until 12 to 15 days after the injury before operating. In fractures of the arm, forearm, or leg, the period is 8 to 10 days. A patella does best if sutured at about the tenth day after the injury. In children the time is shortened to 4 to 6 days. On the other hand, if osteosynthesis is performed immediately after the injury the introduction of foreign material has a tendency to cause a delay in union. This theory has been confirmed by a number of recent cases on which, for reasons independent of his will, he operated immediately after the injury. In all of them union was delayed.—*J. Albert Key, M.D., Baltimore.*

THE VALUE OF GRANT'S PINS IN THE OPEN TREATMENT OF FRACTURES AS SEEN ROENTGENOLOGICALLY. D. Y. Keith and J. Paul Keith, M.D. *Am. Jour. of Roentgenology*, March, 1923.

The writers describe the mechanism and construction of Grant's pins, give the history of their creation and use by Dr. H. H. Grant up to 1915, the weaknesses of the pins as used by Grant, and describe the improvements which they have made, the improvements giving greater strength and convenience.

Surgical points emphasized are: screws should pass through the medullary canal to opposite cortex; screws must be of good metal to insure greater strength. Drill holes should be same size as gimlets. Reduction is better in experienced hands, excellent in the skilled surgeon's hands. Especially excellent for aid in reduction and maintenance of position in the robust, where violent muscular action is such a potent factor in the production of malposition; also at points where displacement is so prone to occur. These pins lessen trauma in the process of reduction. The pins are easily removed, requiring no anesthetic. They are easily applied, can be used easily in compound fractures. Thirteen cuts are given illustrative of the pins and various forms of fractures and their treatment.—*William Jackson Merrill, M.D., Philadelphia, Pa.*

A New Method or Treatment of Irreducible, Acquired or Congenital Hip Dislocations. By Adolf Lorenz, M.D. *New York Med. Journ. and Med. Rec.*, Feb. 7, 1923.

The following conditions, luxations, pseudarthrosis colli femoris, coxa vara luxans, have something in common anatomically, and there arises a nearly equal disturbance of function. This disturbance in function is due to a loosened connection of the upper end of the femur with the pelvis. The pelvis has lost the direct bony support of the femur; is merely suspended at its upper parts by soft and yielding tissues, the pelvitrochanteric muscles, and the capsule. These soft parts, subject to undue strain, especially in adults of heavier weight, become painful.

The limping of such patients is due not only to deficient bony support of the pelvis, but also to the fact that the power of the pelvitrochanteric muscles is deficient, for by the shortened distance of their points of insertion they have become too long, have lost their normal leverage, and besides are weakened from disuse. The contralateral side of the pelvis drops until the lateral aspect of the tuber ischii reaches contact with the inner aspect of the upper femur. The lateral dropping of the pelvis at each step accounts for the adduction contraction. The point is stressed that flexion and adduction are very commonly seen in this group of cases.

The purpose of the so-called bifurcation operation is to provide a bony support in place of the yielding soft tissue support. This is accomplished by oblique osteotomy at the level of the acetabulum. The upper end of the lower fragment is thrust against the capsule and held in this position by abduction, while the lower end of the upper fragment is adducted and made to lie in contact with the lower fragment. In this way the upper end of the lower fragment becomes an artificial head, giving stability, while the adducted position of the upper fragment gives better action to the pelvitrochanteric muscles. The operation entails some shortening which, however, can be equalized by the tilting of the pelvis at the site of the operation. Stress must be laid on the fact that not the shortening, but the elastic suspension of the body upon the upper end of the femur is the source of the troubles of the patient. The operation also causes some impairment of motion, chiefly flexion.

The results in properly selected cases have been good, particularly as to function, but the cosmetic results have also been very satisfactory.

Some sixty patients have been operated upon by this method.

Description of the Operation.

The patient is placed upon the sound side, the diseased thigh being slightly flexed so as to cover the site of the acetabulum. A longitudinal incision of about ten centimeters is made through the skin and muscles until the outer surface of the femur is laid bare. Oblique osteotomy is then done, a long and oblique line extending from the anterior aspect posteriorly and distally. The upper extremity of the cut should correspond with the upper level of the acetabulum. The limb is abducted until the upper end of the lower fragment comes to rest in the empty acetabulum, that is, on the anterior capsular wall. The lower end of the fragment is pushed inwards and made to lie in contact with the outer surface of the upper end of the lower fragment.

The limb is fixed in thirty-five degrees of abduction in a plaster of Paris spica from the waist to the toes, taking care to maintain adduction of the upper fragment by tightening the rollers over the operative field. The patient is allowed up on crutches in about two weeks, in six weeks the bandage is cut and the knee joint moved, and in three months all support is removed.

The after treatment consists of massage and gymnastics of the pelvitrochanteric muscles.

In conclusion the author states that his bifurication operation is applicable:

1. In cases of irreducible congenital hip dislocation.
2. Eventually in cases of refractory congenital luxations.
3. In irreducible traumatic hip luxations.
4. In pathological dislocations due to osteomyelitis or tuberculosis.
5. In the severest cases of coxa vara (Coxa vara luxans).
6. In cases of pseudarthrosis colli femoris.
7. In cured cases of tuberculosis of the hip complicated with frequent attacks of severe pain.
8. Eventually in cases of severe arthritis deformans coxae in older patients, to control pain by relieving pressure in the joint.

The article is a long one with a number of drawings and could be read with interest by those who deal with this group of cases.

—*LeRoy C. Abbott, M.D., Ann Arbor, Mich.*

Open Intervention in Malleolar Fractures. G. Picot. *Jour. de Chir*, 21, 529, 1923.

The irreducibility of certain malleolar fractures and the poor results in those not completely reduced led the author to operate on twelve recent cases. All showed fractures of the posterior margin of the tibia which were not always visible in the X-ray plate.

An operation suitable for the majority of cases is described. The approach is by a J incision along the lateral border of the tendo Achillis and swung inwards distally. The tendo Achillis is divided obliquely and turned back, the communicating artery is cut between ligatures, and the flexor longus hallucis is cut from the fibula in the lower portion of its attachment and retracted mesially to expose the seat of the fracture. The periosteum of the tibia is incised and the fracture is reduced by hooking up the proximal fragment, while an assistant flexes

the foot and presses down upon the distal fragment. Coaptation must be perfect. Fixation is maintained by a screw. The wound is closed in layers and the tendo Achillis is lengthened. Movement is begun on the fourth or fifth day and walking in thirty days. Good results were obtained in all 12 cases.—*J. Albert Key, M.D., Baltimore.*

THE RATIONAL TREATMENT OF FRACTURES OF THE UPPER END OF THE HUMERUS: REPORT OF END-RESULTS. James Warren Sever. *Journal A. M. A.*, June 2, 1923, p. 1603.

Author emphasizes the absolute necessity of the abduction treatment of fractures of upper end of the humerus and notes the generally poor results obtained in these fractures as a result of the usual method of treatment with reference to subsequent function. He declares that better results will be obtained in less time if traction following the reduction of the fragments is used in the abducted and outwardly rotated and elevated position rather than by using the older and usual method which employs the shoulder cap, sling, and Velpeau bandage.

Classification of Fractures of Upper End of Humerus

Class 1. Simple fracture of greater tuberosity without displacement: A. With upward and outward rotation of fragment, may be associated with dislocation of shoulder.

Class 2. Simple fracture of surgical or anatomic neck without displacement, or with impaction of fragment: A. With displacement of fragment, but without dislocation of head: B. With displacement of fragments and complete dislocation of head, generally subcoracoid.

Class 3. Fracture of neck of humerus, generally comminuted, with fracture of shaft, without dislocation of head.

Conclusions

These points are essential in the treatment of fractures of the upper end of the humerus:

1. Anatomic restoration of fragments is best obtained by abduction, outward rotation, and elevation of the humerus.

2. Traction in this position is essential for from four or five days to two or three weeks.

3. A satisfactory ambulatory splint may be employed rather than bed treatment.

4. Better and more quickly obtained functional results may be secured by this method than by any other.

5. Operation, except in certain cases of fracture dislocations, is generally unnecessary to restore fractured surfaces.—*E. Z. Holt, M.D., Atlantic City, N. J.*

A CASE OF FRACTURE-LUXATION OF THE CERVICAL SPINE. E. Vandeput. *Arch. Franco-Belges de Chir.*, 1922, 25, No. 10, p. 942.

The case reported is that of a young man who, while swimming, dove and struck another swimmer. Immediate quadriplegia resulted. There was dissociated root paralysis of the upper extremities with complete motor and sensory paralysis below

the sixth cervical. There was abolition of the deep reflexes and loss of sphincter control. An X-ray showed a fracture and backward displacement of the fifth cervical vertebra. A diagnosis of total anatomic section of the cord was made and operative interference was not deemed justifiable. Bed-sores developed rapidly and the patient died. Autopsy proved the diagnosis to have been correct. The author states that the diagnosis of complete anatomic and functional section is not always as clear as in this case and that when there is any doubt of the condition a laminectomy should be performed on the second or third day in order to relieve pressure and limit degeneration.—*J. Albert Key, M.D., Baltimore, Md.*

Retrosternal Luxation of the Clavicle. Conservative or Operative Treatment? Kurt Wachendorf. *Zentralbl. f. Chir.*, March 31, 1923, p. 514.

From the review of the limited number of reported cases, the author concludes that surgeons have disregarded the conservative treatment in favor of the operative. He quotes a case which, notwithstanding its unfavorable complications, has yielded an excellent permanent result without operative procedures. Briefly the history is as follows:

Man of 49 was thrown off a wagon and struck the left side of his chest. Examination revealed a marked swelling and blue-red discoloration extending from the sternum to past the left mammary line and from the fifth rib to above the left clavicle. Intense pain with each breath. Distinct crepitation over second to fifth ribs. In the region of the left sterno-clavicular joint was a depression and the edge of the sternum was decidedly palpable; the sternal end of the clavicle, not palpable, was lost behind the sternum. Abduction of the arm painful, and possible to the horizontal position only. X-ray showed a typical sterno-clavicular dislocation and multiple rib fractures near the sternum.

Treatment.—Adhesive strapping for the rib fractures. Forcible backward pressure of both shoulders resulted in a comparatively easy replacement of the dislocated clavicle. Patient was placed on the back with a sandbag between the shoulders and another sandbag on the left shoulder to guard against reluxation. The next day slight motion subluxated the clavicle again. Second replacement with the same ease, and retention of both arms in extreme backward position by means of circular bandages. Patient placed on his back as before. Twenty-six days later uneventful recovery and discharge of patient from the hospital. Arm motion was free and painless. The fractured ribs, though healed, were not in perfect apposition, viz., the outer fracture ends were displaced mesially to the sternal fracture ends. In consequence of this the diameters of the chest varied on the two sides, the left being somewhat flatter than the right. Notwithstanding this untoward complication which would hinder replacement and favor reluxation, the result was an excellent one with conservative treatment. This speaks, at least, for a trial of the nonoperative method.—*A. Gottlieb, M.D., Los Angeles, Calif.*

POSTURAL DEFECTS.

Results of Exercise for the Correction of Postural Defects. By Robert Jay Cook, M.D. *New York Med. Journ. and Med. Rec.*, Feb. 7, 1923.

The common postural defects found among men entering Yale are round shoulders, increased antero-posterior curvature, as kyphosis or round back, lordosis or

hollow back, scoliosis, either postural or structural, flat chest, prominent abdomen, and weak feet, which term includes the several types of foot strain and foot abnormalities.

The author calls attention to the fact that in two examinations of Freshmen of Yale,—in the first instance, 1,393 men, and in the second instance 2,200,—but 25 per cent. of these men had a normal spinal curvature, that over 50 per cent. had an antero-posterior curvature. The chest was flat in 56 per cent. of cases and the abdomen was prominent beyond the normal in 42 per cent. of the men.

These defects are found in men who have just completed the preparatory school.

The author makes a plea for corrective therapy during early life so that the poor postures found so commonly among adults may be avoided.

It is interesting to note the postures of men entering from various preparatory schools. In general those from military schools lead, boys from private preparatory schools come next, and following this the high school group. Following the war there was exception to this and those who had been under military training in high schools outrated many who had been in private preparatory schools.

The general plan of treatment has been to give the correctional work from Thanksgiving to Easter, a period of fifteen weeks. The contracted muscles are stretched, effort is made to obtain greater flexibility of the thorax and freedom of the shoulder girdle, then increase in tone of the trunk muscles.

In the past two years five hundred men have been examined and grouped according to postural defects.

The man who had scoliosis combined with increase in the antero-posterior curvature improved both conditions, even though his exercises were directed mainly at overcoming the major one.

A number of tables are given showing the following results: In increased antero-posterior curvature of the spine, 66 cases of kypholordosis, 53 cases of kyphosis were corrected, 116 cases of kypholordosis were partially corrected, and 8 cases of kyphosis were partially corrected. There were 80 cases of kypholordosis and 40 cases of kyphosis in which no correction was made and 9 cases in which the defect became worse. Correction of round back is the most difficult part of the problem in the correction of the postural defects in this group of men.

Table II deals with carrying of the head and neck too far forward. Correction of this deformity has been quite satisfactory. In many cases it is associated with round back. The author urged correction of this deformity as well as the correction of carrying the neck and head too far forward. In this group 212 cases were completely corrected, 145 partially corrected, while 73 cases showed no improvement and 8 cases showed an increase in the carrying angle of the neck.

The result in the correction of round shoulders shows that 168 were completely corrected, 189 partially corrected and 90 cases showed no improvement, while 7 showed an increase in defect.

Our failure in part seems traceable to the attitude of the student and part may be due to pushing too rapidly the man who has outgrown his physical strength.

Reviewing our cases of postural scoliosis we find 101 cases completely corrected, 94 partially corrected, 62 show no improvement, and 21 show an increase in curvature.

These defects of posture found among young men do not tend to disappear without corrective work, but they can be overcome by this training, some by the nature

and severity of the defect requiring a longer period than others. Since they are formed long before the student enters college a great deal could be accomplished by preventive measures instituted in the grade and high schools. The question is often raised as to whether the correction is permanent or temporary. We have examined in the past fall those who were given correctional work in the preceding year and in these cases we can say that the improvement has remained.—*Le Roy C. Abbott, M.D., Ann Arbor, Mich.*

Faulty Posture as a Cause of Obscure Digestive and Nutritional Disorders; Report of Treatment in Fifty Cases. Percival Nicholson, M.D. *Pennsylvania Med. Journ.*, Feb., 1923.

This brief article presents certain factors as causes of faulty postures and some of the consequent sequelae. The author states that in the study of adults ("recruits of the world war") nearly 50 per cent were incapacitated by faulty posture, that it is essential to have a "clear understanding" of normal posture, but does not emphasize the fact that each case is a problem *per se*, that no pattern of rules governing habits of good posture can be made to correctly apply to all cases. He does not bring out the fact that the position of the shoulder girdle depends upon the contour of the chest and that the position of the scapulae is chiefly controlled by the shape of the chest.

He outlines some rules of good posture for the trunk but does not give sufficient stress to the importance of maintaining a high position of the sternum and anterior chest. If the sternum be held high, the cervical, dorsal, and lumbar spine and the pelvis will fall into the normal position for that individual, if the feet are parallel and the knees straight.

Nicholson points out some of the skeletal and visceral changes that result from faulty posture; alludes to congenital (meaning apparently conditions affecting the primary development in the embryonal period) factors that predispose to faulty posture; briefly discusses "acquired poor posture," but does not emphasize here the fact that bad posture is usually a sequela, not a first cause. He discusses briefly the serious effects of skeletal deformities, and gives a special place to cases resulting from unbalanced diet (we recall the fact that thousands of children have "unbalanced diet" and yet good posture). He points out very pertinently the dangers of giving muscles their function too soon after depleting illness. He states the "symptoms" vary as to the character and extent of the postural defect and its duration, but does not add to these conditions the influence of the personal equation. He enumerates defects and states that they are due to "incorrect bodily mechanics," and here leaves out many associated vital conditions. Eight cuts illustrate variations in posture. Eleven cases are reported. The efficiency of a proper abdominal belt is emphasized under "treatment."—*William Jackson Merrill, M.D., Philadelphia, Pa.*

BONE SURGERY.

The Lorenz Bifurcation Operation. A Preliminary Report. By Dexter D. Ashley, M.D. *New York Med. Journ. and Med. Rec.*, Feb. 7, 1923.

The author states that time and again patients have come to him with long standing deformities of the iliofemoral articulation—unstable, painful—due to dis-

ease, fracture, or congenital malformation. For these patients he has been unable to suggest any satisfactory method of relief.

The bifurcation operation of Lorenz has been of great benefit in obtaining relief and it is a simple operation without any risk. The details of the technique are given, but are quite similar to those stated in the previous article.

The broad application of this operation can hardly be appreciated at first glance. Foremost of the conditions to be benefited is the old, ununited fracture of the neck of the femur. If this operation were applicable to this condition alone, it would be a remarkable addition to our surgical procedure. In the second place this operation is indicated in pathological, unstable conditions due to tuberculosis, acute infections, acute arthritis neonatorum. Third, it is available also in cases of old, painful congenital dislocations, or pathological dislocations after typhoid fever, osteomyelitis, and other similar conditions.—*Le Roy C. Abbott, Ann Arbor, Mich.*

THE SURGICAL CORRECTION OF DEFORMITIES OF THE EXTREMITIES. M. Cadenat. *Journal de Chirurgie*, March, 1923, p. 273.

The author discusses the difficulties encountered in cutting an oblique wedge for the correction of a deformity in two planes. To overcome this he has devised a guiding compass adjustable in two planes. Tracings are made from roentgenograms taken at right angles to one another, and the angles of the required wedge are determined in the usual way by cutting and straightening the tracings. The compass is set at the required angles and boiled with the instruments. In operating, the bone is cut at approximately right angles and the compass then used to guide the saw in cutting the oblique wedge from one bone end. The method permits of an exact correction of the deformity. However, it has been the experience of the reviewer that the chief difficulty in these operations is not so much the bone carpentry as it is the difficulty in holding the bones in the correct position while the plaster bandage is being applied.—*J. Albert Key, M.D., Baltimore.*

TRANSFERENCE OF THE CREST OF THE ILIUM FOR FLEXION CONTRACTURE OF THE HIP. Willis C. Campbell. *Southern Med. Jour.*, April, 1923, p. 289.

This operation is intended for severe flexion contracture at the hip. It is more extensive than the Soutter operation, although founded upon the same general principle. It is also said to overcome any associated abduction deformity at the hip. The operation is as follows: "The skin is incised along the anterior half or two-thirds of the crest of the ilium to the anterior superior spine and then downward to the outer aspect of the rectus muscle for about two to four inches, a typical Sprengel approach to the hip, recently advocated by Smith-Peterson. The superficial and deep fascia are incised to the crest and anterior superior spine. With sharp osteotome the anterior superior spine is removed. The outer one-fourth of the crest is chiseled through, from before backward, or the anterior two-thirds or the entire crest, as the occasion demands, after which a heavy osteotome peels the entire mass subperiosteally downwards to the rim of the acetabulum, above which

a tract of bone is denuded about one inch in diameter and parallel with the crest of the ilium. The raw surfaces of the transferred crest of the ilium and anterior superior spine fall, by gravity, so that raw bony surfaces approximate. If this does not reduce the flexion, the anterior structures, such as the psoas, fascia, or capsule of the hip joint, may be easily attacked. The superficial fascia above is stitched to the deep fascia at a point below, bringing the skin incision about one inch below the crest of the ilium, avoiding possible pressure. The skin is closed with dermal sutures. Plaster cast is applied in hyperextension, which remains eight weeks." He has had no fatalities or alarming symptoms. This seems to be an advance over the excellent Soutter operation and should be a great aid in the severer cases. The operation is illustrated and some photographs shown.—*F. G. Hodgson, M.D., Atlanta, Ga.*

RESEARCHES ON GRAFTS OF BONE FIXED IN ALCOHOL AND ON THE MECHANISM OF OSTEOGENESIS. L. Christophe. *Archives Franco-Belges de Chirurgie*, 26, 13, Jan., 1923.

The work was undertaken in an effort to explain a remarkable case operated upon by Professor Delrez in which an intact patella with the patellar ligament and part of the quadriceps tendon was removed from a man at autopsy, fixed in 80 per cent. alcohol for three days, and then transplanted to the knee of a man who had had his patella removed in débriding a shell wound. The dead patella was not only tolerated, but normal function was restored to the knee, and in the roentgenogram taken four years later the patella appeared to be perfectly normal.

This was a brilliant application to bone of the researches of Nageotte and Sencert on the transplantation of dead grafts of tendons and nerves.

Christophe used rabbits, foxes, and dogs. Most of his experiments consisted of the transplanting of alcohol fixed ribs of rabbits. Some of the grafts were first boiled and then fixed in alcohol. From studies on the grafts removed at various periods up to four months after the operation he concludes that dead grafts of the rabbit bone transplanted into another rabbit of the same sex in a position of physiological function frequently are not absorbed but are repopulated by living cells which migrate in from the host.

After thirty-four days the graft cannot be distinguished microscopically from the normal living bone of the host.

In cases where the graft was transplanted to an animal of the opposite sex there was no rehabilitation and the graft was absorbed.

Two clinical cases of the transplantation of alcohol fixed bone into the shafts of long bones are reported. In one of the grafts was a segment of the shaft of the humerus 11.5 cm. long. Both were successful.

Christophe feels that resorption of grafts is a serous phenomenon in which the osteoclasts have no part. There is a general dissolution of the calcium salts and ossein (the organic matrix of bone) by the plasma The function of the osteoclasts is local absorption or canalization of growing bone. Likewise the formation of new bone is not accomplished by osteoblasts but is accomplished by an extracellular precipitate of ossein which is in the early stages acellular. In some unknown manner this ossein withdraws calcium salts from the bone and becomes bone. This theory of bone formation is similar to that of Heitz-Boyer.

The paper is illustrated by numerous photomicrographs. The idea of the persistence of the graft and its repopulation by living cells from the host is very different from what we believe happens even in living autogenous grafts. The work is of fundamental importance and deserves repetition and confirmation.—*J. Albert Key, M.D., Baltimore.*

THE TREATMENT OF CONGENITAL PSEUDARTHROSIS BY OSTEO-PERIOSTEAL GRAFTS. C. Dujarier and M. Perrin. *Jour. de Chir.*, 21, 401, 1923.

Five cases of persistent non-union of fractures in young children are reported. All were treated successfully by the osteo-periosteal graft of Delagénière. The authors recommend this method for these notoriously difficult cases because they believe that it succeeds more often than does the rigid Albee graft, and being composed of a very thin strip of bone and periosteum it does not weaken the opposite leg as do the free Albee grafts or the pedunculated grafts of Reichel. The Delagéniere grafts grow rapidly.—*J. Albert Key, M.D., Baltimore.*

RESEARCHES ON GRAFTS OF EMBRYONIC BONE. R. Simon and M. Aron. *Archives Franco-Belges de Chirurgie,* July, 1922, 25, No. 10, p. 869.

The authors review the scanty literature on the transplantation of embryonic bone and give the results of their own experiments. Under aseptic conditions they removed the long bones from guinea pig foetuses of 70 to 105 mm. long and transplanted them immediately into young or adult guinea pigs. They were usually placed in the subcutaneous tissue of the back and were removed and studied after periods varying from 15 days to 3½ months. The gross and microscopic changes are given in detail.

In the cases in which isolated bones stripped of the surrounding muscles were transplanted, the graft underwent a slow evolution which eventually resulted in the death of all of its constituents, just as does a graft of adult bone which is absorbed and replaced by new bone. In the grafts of embryonic bone, however, the evolution is more slow than in the grafts of adult bone and is often preceded by proliferation of the epiphyseal cartilage cells with temporary thickening of the epiphysis, and occasionally of the shaft from periosteal proliferation.

In the cases where two adjacent bones with the joint were transplanted en masse, the joints subluxated, but mobility was preserved and the degeneration was so slow that grafts were little changed after three months.

In a few cases the skin only was removed and the entire limb was transplanted. In these, after four weeks, the bones were definitely longer and thicker and preserved their normal proportions. The authors attributed this to the mechanical effects of the transplanted muscles, which retained their cross striation and appeared to be living.—*J. Albert Key, M.D., Baltimore, Md.*

VERTEBRAL AFFECTIONS.

LOW BACK PAIN. R. Wallace Billington. *Southern Med. Jour.*, June, 1923, p. 478.

Author concludes that if one does not find consistently guarded movements, definite limited motions of lumbar spine, or persistent and consistent faulty attitude or deformity, there can be little, if any, disability due to the alleged injury or disease of the spine or sacro-iliacs.

He gives five definite causes for low back pain: (1) trauma, including strains, sprains, fractures, dislocations, etc.; (2) faulty posture, with relaxed ligaments and muscles; (3) diseases of the spine and sacro-iliac joints; (4) intra abdominal and pelvic pathology; (5) skeletal malformations, defects, and deformities. Treatment is not discussed.—*F. G. Hodgson, M.D., Atlanta, Ga.*

SACROILIAC ARTHRESIS OBLITERANS. By Edward S. Blaine, M.D. *Am. Jour. of Roentgenology*, March, 1923.

Blaine presents facts acquired from 1800 cases, 18 of which present unusual changes in the sacroiliac joints. Symptoms enumerated are—"dull pain, soreness and stiffness of the back, with uncomfortable feeling in the lower spine," coming on gradually, progressing for several months to a year or more. Incipiency indefinite, movement of spine restricted. Pathology and etiology not stated except that it is an infectious osteo-arthritis.

Joint changes—destructive and constructive progress, joint cartilage is absorbed, joint is fused and joint lime disappears.

In his X-ray differential diagnosis, he mentions septic arthritis. This condition is undoubtedly a septic arthritis and of the hypertrophic osteo-arthritic type. It is not necessary to differentiate this from tuberculosis of the sacroiliac joint.—*William Jackson Merrill, M.D., Philadelphia, Pa.*

SPONDYLOLISTHESIS. S. Kleinberg. *Annals of Surgery*, April, 1923, p. 490.

In this article, the author emphasizes three points: (1) the condition occurs more frequently in males than we have heretofore believed; (2) the lesion presents a radiographic appearance which is pathognomonic, and (3) trauma is frequently the direct cause, or at least, a very important factor, in its etiology.

The fifth lumbar vertebra is tilted forward so that its superior surface is directed upward and forward. This inclination has been assumed to be a weak point in its relationship with the sacrum. The radiographic appearance of the lumbo-sacral region varies according to the location of the X-ray tube in relation to the last lumbar vertebra. In a normal spine the lumbar vertebrae all appear as quadrilateral shadows in an antero-posterior view if the central rays pass through the lumbo-sacral region. If the tube is opposite the dorsal region all the lumbar vertebrae appear rectangular except the last one. The area occupied by the fifth is diminished and one sees two oblong masses joining medially at an obtuse angle. In spondylolisthesis, with the last lumbar vertebra dislocated anteriorly, in a front view of the patient we are looking at the superior surface of the last lumbar vertebra, and this condition can be detected in an antero-posterior X-ray. A lateral view will clinch the diagnosis, but in the very obese this is difficult or impossible to get.

It has been argued that such a severe lesion could hardly be the result of the degree of trauma usually mentioned by these patients. Probably these patients have an anatomical or developmental defect in this region, but there is evidence to support the idea that trauma is the primary etiologic factor.—*William R. Smith, M.D., Atlanta, Ga.*

THE TREATMENT OF PAINFUL AFFECTIONS INVOLVING THE CERVICAL VERTEBRAE. Harry Leslie Langnecker, M.D. *California State Journal of Medicine*, January, 1923.

In making a survey of a large number of private and clinic cases, the author divides the affections involving the cervical vertebrae into the following classifications:

Group I. Severe injuries and inflammations in which immobilization and fixation were used.

Group II. Arthritic cases in which a search for infectious foci was carried out.

Group III. Cases complaining of pain in the neck in which after radiographic examination no evidence of organic disease was found and the patient was told to "forget the pain in the neck."

This failure to recognize and treat these defective posture cases frequently leads to permanent disability and often causes the patient to try measures which may retard recovery and which may prove harmful.

After a correct diagnosis is made, treatment should be given to restore function to a maximum degree or prevent increasing disability.

Treatment should be directed toward elimination of infectious foci, correction of postural conditions, rest by complete or partial fixation, improvement of muscular and ligamentous tissue tone by active hyperaemia. Movement should be attempted early while still in fixation stage, and carefully selected active exercises should complete the treatment.—*C. L. Lowman, M.D., Los Angeles, Calif.*

BACKACHE AS A CAUSE OF CALCAREOUS DEGENERATION OF THE DORSAL AND LUMBAR AORTAE. John Ridlon and Elven J. Berkheiser. *Journ. A. M. A.*, June 23, 1923, p. 1831.

The authors believe that a certain portion of the very large numbers of painful backs for which one cannot account are due to circulation changes: changes that give loss of expansibility and contractibility and hence to ischemia of the musculature, calcareous degeneration in both the thoracic and the abdominal aorta without other roentgen ray evidence of pathologic conditions of bone or joint. For years, we have known that circulatory disturbances were associated with muscular pain and stiffness. Since it has become generally recognized that discomfort in the feet is due to an impaired circulation, we have thought it fair to assume that discomforts in other parts of the body as well may be due to impaired circulation in the muscles of the particular part. Bone spurs are a cause of sensitiveness to pressure, and, when in close relation to joints, to movement; but they are not a cause of pain: pain is due to the circulatory changes. In the same way in the back, bone spurs and bridges cause sensitiveness and stiffness, but it is the circulatory changes that are responsible for the pain. The authors recommend an examination of the circulatory system in painful back conditions. Many of such cases should be treated by the internist. Girdles, braces, plaster jackets, and extensions should not be employed as a routine. Three case histories accompanied by roentgenograms are included in the paper.—*E. J. Holt, M.D., Atlantic City, N. J.*

KOEHLER'S DISEASE AND LEGG-PERTHES' DISEASE.

KOEHLER'S DISEASE AND PERTHES' DISEASE. G. Axhausen. *Zentralbl. f. Chir.*, Apr. 7, 1923.

Author has repeatedly contradicted the traumatic etiology of this affection and has regarded the impression of the plantar joint surface not as a fracture of normal bone but as a pathological, spontaneous fracture of necrosed bone tissue. Researches on abundant material in the various stages of development substantiate his opinion and complete the picture of the entire course of this disease.

In the very early stage only the epiphysis undergoes *aseptic necrosis;* no loss of continuity of bone and therefore no X-ray changes as yet demonstrable. The accompanying regenerative processes arise from the neighboring metaphyseal periosteum which proliferates in exuberance, so that bone stores up on the outer surface of the shaft. At the same time, the proliferating periosteal connective tissue breaks through the joint cartilage and expands in the marrow space of the dead epiphysis. This break of continuity of the joint cartilage, together with the bone atrophy of the epiphyseal base, robs the dead epiphysis of its firmness; the weight bearing on this weak, dead, and bloodless point of support causes the fracture on the plantar joint surface.

In the second stage of development, to the above picture of necrosis and bone proliferation is added a superficial impression-fracture of the dead epiphysis on the plantar joint surface. The X-ray presents the shadow of a light flatness of the epiphysis with a faint and even condensation of the bone and a slight thickening of the metaphysis. The peculiarity of this pathological fracture is that it involves only necrosed bone, being bordered by dead bone and dead marrow. The healing of such a fracture is an impossibility. Instead of that, the dead fractured bone crumbles and grinds to a powder with each step, and bone flour and crumbs fill the space of the fractured ends and the marrow cavity. The young connective, richly vascular tissue which spreads from the cartilage-bone edge and, later, from the metaphyseal marrow into the marrow cavity of the dead epiphysis, finds resistance in this bone-splinter-wall and cannot, therefore, substitute the fractured bone pieces. It only forms connective tissue layers about this mass of bone splinters.

In the third stage we find, histologically, a piece of dead bone in the subchondral region on the plantar surface. This dead bone encloses dead marrow and is separated from the rest of the epiphysis by means of the bone-splinter-wall and a thick layer of young and old connective tissue which contains numerous giant cells. The X-ray shows now, in addition to the previous shadows, condensed bone shadows, appearing like sequestrae, within the epiphysis. The final stage is an outspoken arthritis deformans with its deforming joint surface, synovial hyperplasia and hypertrophy of the bone edges. Fracture is a frequent sequel of the epiphyseal necrosis, but it may not necessarily occur in each case.

The described histologic findings hold good in the development of Perthes' disease. In both conditions the X-rays are negative in the early stage; in both cases the same changes occur in the course of their development—flattening of the joint surface which appears compressed; condensation in patches which are surrounded by light areas; thickening of the metaphysis and, finally, malformation of the joint end. Proof that both processes are analogous has been substantiated by the his-

tological examination of a specimen, epiphysis of the femur, of an early case of Perthes' disease (reported by Dr. Fruend at the last surgical congress). The findings correspond to the second stage of Koehler's disease. It is beyond doubt that both diseases are of the same nature—aseptic epiphyseal necrosis as a base. The weight bearing upon dead bone and the accompanying regenerative process results, in both instances, in a joint which may rightly be designated an arthritis deformans. The histological pictures and the mode of development of these diseases do not lead to the factor of the primary necrosis of the epiphysis; it, however, excludes trauma as a reason for these malformations.—*A. Gottlieb, M.D., Los Angeles, Calif.*

ETIOLOGY OF KOEHLER'S DISEASE. Duerig. *Muench. Med. Woch.*, March 23, 1923, p. 362.

In the various reports of Koehler's disease the foot configuration is unfortunately not always mentioned. The condition of the foot under weight-bearing is disregarded in most instances, although it is undoubtedly a fact that flatfoot and depression of the anterior arch may usually be disclosed. A few cases, including the one reported in this article, substantiate these findings. The reason why the second metatarsal is affected can be explained through the inefficiency of the muscular-ligamentous apparatus in faulty and excessive weight-bearing which leads to a pes transverso-planus. In the latter, the second and, at times, the head of the third metatarsal is depressed and suffers trauma with each step. On this basis can also be explained the "marching fractures" of the second and third metatarsals.

The existence of the so-called marching fractures on the second and third metatarsals and the phenomenon named Koehler's disease on the second, rarely on the third metatarsal, leads to the presumption that both affections may have a similar etiology, viz.—faulty statics and excessive weight-bearing.

The reported case seems to prove this supposition.—*A. Gottlieb, M.D., Los Angeles, Calif.*

SEPARATION OF THE UPPER EPIPHYSIS OF THE TIBIA. Alexander Gibson, *Annals of Surgery*, April, 1923, p. 485.

Diastasis, or epiphyseal separation, is an accident that is possible only in adolescent life or late childhood. It is rare before the age of twelve. While any epiphysis may be the seat of this injury, the most frequent sites are the lower epiphysis of the radius and the upper epiphysis of the humerus.

While separation of the lower epiphysis of the femur and partial separation of the tongue-shaped process of the upper tibial epiphysis are fairly common, separation of the upper epiphysis of the tibia itself is rare, and detachment of the upper fibular epiphysis alone is unrecorded.

The usual history in the cases of upper tibial diastasis is of a violent wrenching of the leg, together with abduction or adduction. Some writers believe that direct pressure against the epiphysis is the chief factor. The clinical picture suggests backward dislocation of the knee at first sight, but this can be ruled out by the age of the patient, exact interpretation of bony points, and X-ray.

Based on cases reported to date, the prognosis in these cases is not particularly reassuring. The author quotes a series of 24 cases mentioned by Poland, in 12 of which the patient died or the limb was amputated. Shock and septic infection play an important rôle in this condition. If no serious complication arises, however, and reposition is exact, prognosis regarding growth is very good.—*William R. Smith, M.D., Atlanta, Ga.*

Isolated Disease of the Scaphoid. Barclay W. Moffit, M.D. *Journal I. M. I.*, January, 1923.

The condition is important because it has been mistaken for tubercular disease. It was first described by Koehler in 1908.

It occurs in children, from 4 to 8 years of age, and causes a slight limp, pain, tenderness, and enlargement of the bone to the palpating finger.

The etiology is unknown. Trauma has frequently preceded the disease and seems the most likely causative factor, though not the direct cause, perhaps acting through injury of the center of ossification or by tearing nutrient vessels or exciting a dystrophy.

The X-ray shadow of the bone is much smaller than normal. It occupies, however, the same space as a normal bone and the arrangement of the other bones is not altered.

The prognosis is good.

The treatment is rest or immobilization for three to ten weeks.

The author concludes that the scaphoid becomes enlarged because of trauma, and undergoes a compression fracture through weight-bearing because of this enlargement.—*C. L. Lowman, M.D., Los Angeles, Calif.*

MISCELLANEOUS.

Case of Cubitus Varus. A. Contargyris. *Revue d'orthopédie*, March, 1923, p. 161.

The author reports a case of a soldier, who, at the age of six years, fell and suffered a cubitus varus deformity of the left elbow. Flexion is slightly limited; also extension, but pronation and supination are normal.

From the point of view of pathogenesis, the author thinks that his case supports the osteogenic theory of Rieffel, by which he explains both the mechanism of cubitus varus and its symptoms. The osteogenic theory in this case has in its favor: (1) the age (6 years) of the patient at the time of the traumatism; (2) the appearance of the deformity after the apparatus was discontinued; (3) the radiographic findings—no irregularities, but atrophy of the trochlea and lack of union of this with the humeral epiphysis at the age of twenty-four, that is, eighteen years after the traumatism.

Inflammation of the Deep Calcaneal Bursa. A. E. Hertzler. *Jour. of the Am. Med. Assn.*, 81, No. 1, 8, July 7, 1923.

The author describes an inconstant bursa lying beneath the abductor hallucis muscle. Inflammation of this bursa causes pain and tenderness in the front part of the heel, just anterior to the attachment of the flexor muscles. The usual signs of flat foot are absent. Cure is obtained by curetting and draining the bursa through a small incision below and in front of the sostentaculum tali.—*J. Albert Key, M.D., Baltimore.*

Some Less Frequently Considered Portals of Infection in Arithritis and Iritis. Ernest E. Irons. *Journ. A. M. A.*, June 30, 1923, p. 1899.

Less frequently considered portals of entry of recurrent infections: (1) mucous membrane of upper respiratory tract; (2) tissues about hila of lungs; (3) intestinal tract. The problem is evidently concerned with (1) the passage of bacteria through the stomach and their fate in the small and large intestine; (2) the permeability of the mucosa of the intestine for small particles and for bacteria, and (3) the survival of these bacteria in the lymphatics, lymph nodes, and blood, and their subsequent lodgment in the eyes, joints, and other structures. These are numerous case reports of iritis associated with gastro-intestinal upsets, constipation or diarrhea, in which healing of the iritis has apparently been hastened by treatment directed toward the intestinal tract, either by laxatives or by modifications in diet, with the elimination or reduction of proteins, fats, or carbohydrates. The satisfactory demonstration of direct invasion through the intact intestinal mucosa of man by organisms which can cause arthritis without continued general infection presents difficulties that so far have not been overcome. That the intestinal tract may sometimes be the portal of entry of recurrent metastatic infection seems certain. *E. Z Holt, M.D., Atlantic City, N. J.*

Transplantation of the Tensor Fasciae Femoris in Cases of Weakened Gluteus Medius. Arthur T. Legg. *Journal A. M. A.*, January 27, 1923.

Describes the limp caused by a weak gluteus medius, and calls attention to the action of this muscle in keeping the body from falling to the opposite side when the weight is borne on one leg.

Gives the technique of the operation, which frees the tensor fascia with a portion of the fascia lata into which it is inserted, and implants this insertion of the muscle into the outer surface of the femur, about two and a half inches below the great trochanter, under an osteo-periosteal flap. The leg is put up in a plaster spica with thirty degrees of abduction.

The after treatment includes walking in the spica, and muscle training after four weeks, and the substitution of an abduction walking splint after two months, which is worn for six months.

Reports fifteen operations, with very satisfactory results.

Specifies that selection of cases for this operation should exclude those in which the limp is due to weakness of both gluteus maximus and medius, and those in which it is due to weakened lateral abdominal muscles.

The author believes the operation will give increased muscle support to the hip joint and so tend to prevent dislocations from weakened muscles around it.—*L. C. Lowman, M.D., Los Angeles, Calif.*

Anatomic Forms of Flat Foot. Nové-Josserand. *Revue d'Orthopédie*, March, 1923, p. 117.

By means of the X-ray findings flat feet are divided into simple, congenital, and those due to calcaneo-scaphoid synostosis. The simple flat foot is described as an adduction and pronation of the posterior tarsals with the scaphoid accompanying the head of the astragalus in its descent, but subluxating laterally to cause a valgus deformity of the fore foot. In the four congenital cases reported in this paper the lowering of the head of the astragalus is more marked (170 to 180 degrees as compared to a maximum of 145 degrees in the acquired type), and the scaphoid and cuboid tend to subluxate upwards and carry the fore foot into dorsiflexion. Two cases are reported with an apophysis springing from the anterior superior part of the os calcis and articulating with the scaphoid. The displacements are those of acquired flat foot but require more radical treatment.—*J. Albert Key, M.D., Baltimore.*

Hemorrhagic Ostenomyelitis: Report of Case. Max Strunsky. *Journ. A. M. A.*, June 23, 1923, p. 1833.

Incorrectly diagnosed by good surgeons for six months. Operation:—A large cavity filled with viscid degenerated bloody material was found. Cavity was evacuated, walls curetted and painted with alcohol and iodine. Incision was enlarged over entire length of tibia. Entire crest of tibia was removed with circular saw. The graft was cut into fragments and dropped into the cavity. Only 1/3 of cavity was filled. The skin was sutured and patient made an uneventful recovery. It took 18 months for complete regeneration of bone. The author recommends radical surgery in such cases. In this case the fragments acted as a bridge over which new bone grew. The symptoms in this case preceded for some time the roentgenologic appearance of bone liquefaction and absorption. One should be on guard when trauma is followed by an apparent recovery and followed again by symptoms. *E. Z. Holt, M.D., Atlantic City, N. J.*